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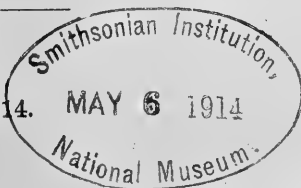
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PROCEEDINGS

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1. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.

XII. FURTHER OBSERVATIONS UPON THE GENUS *UROCYSTIDIUM* BEDDARD.

[Received November 12, 1913: Read February 3, 1914.]

(Text-figures 1-9.)

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In December 1912* the Society published a communication of mine upon a tapeworm from the Musquash (*Fiber zibethicus*), of which I was able to describe both the immature and mature stages which lived side by side in the liver in cavities which are probably to be regarded as dilated portions of the liver-ducts. In May of last year I found some more examples of the same or a closely allied worm in the same situation in another specimen of the Musquash.

In this second case of infection the parasites, as in the first case, consisted of asexual and sexual examples, thus confirming my original discovery that the two generations of the worm lay side by side in the same organ of their host. The asexual

* P. Z. S. 1912, pp. 822-850.

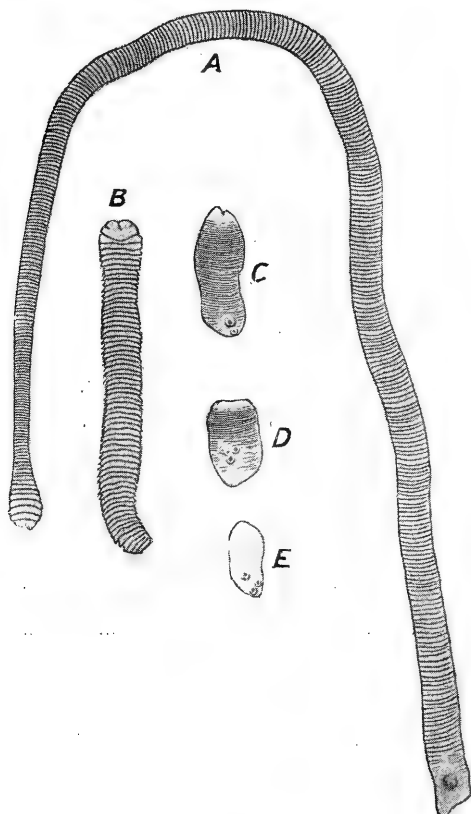


individuals were five in number, of which four are figured in text-fig. 1; the fifth was an obviously incomplete individual. I shall commence the present communication to the Society with an account of

§ *The Asexual Forms.*

The series of examples which represent the asexual phase of this *Urocystidium* showed no budding such as I originally

Text-figure 1.



- A.* Completely developed asexual stage of *Urocystidium*. *B.* Incomplete individual belonging to asexual generation. *C, D, E.* Three younger individuals of the asexual generation which represent stages in the development of the asexual form *A.*

described as the most salient and novel character in this genus. The specimens, however, which I am now about to describe, are not inconsistent with a development of this kind. That is to say,

there are no reasons for the belief that the budding which I formerly described was in any way abnormal in the species.

For it seems to me to be possible, though, as I shall point out later, by no means certain, that the three maggot-shaped worms represented in text-fig. 1 may be looked upon as newly liberated buds, perhaps being derived from the very long specimen (text-fig. 1 A) which has since ceased to produce buds. This latter specimen measured 83 mm. in length by a greatest diameter of 3.5 mm. This greatest diameter was at one end of the body; at the other end it measured only 2 mm. There were intermediate widths in different regions. Although the greater width of one end of the body suggested that this was a bladder such as I described in the original specimen, the segmentation was observed to be continuous here as elsewhere.

The same text-figure (text-fig. 1) illustrates the three younger asexual forms, which were of varying size, the largest being presumably the eldest. In any case I have found that the intermediate sized specimen is older than the smallest. The largest measured 9 mm. in length by 4 mm. in diameter. The proportions of the other two to it and to each other are correctly shown in the drawing referred to. These embryos show a segmentation least marked in the smallest example. It is a rather fine cross wrinkling; but, as I shall show in the sequel, is a true segmentation. When these embryos were living and rather transparent, they exhibited spherical spaces in the interior, visible through the outer wall, which are shown (and somewhat exaggerated) in the text-figure which has just been referred to. These cavities obviously suggest an internal budding of scolices as in *Camurus*, etc.; but it is not by any means clear that they are of that nature.

I examined the smallest of these three young worms by means of a complete series of transverse sections, and the middle-sized one in longitudinal sections; the structure has been compared with that of the fully grown asexual worm described in my earlier paper upon *Urocystidium*. I have, however, made some fresh sections of the fully grown asexual worm for the purposes of this comparison. The structure of the very immature maggot-like larvæ explains certain features in the structure of the fully grown asexual form which I was formerly unable to explain. I shall, however, preface these comparisons by a detailed account of

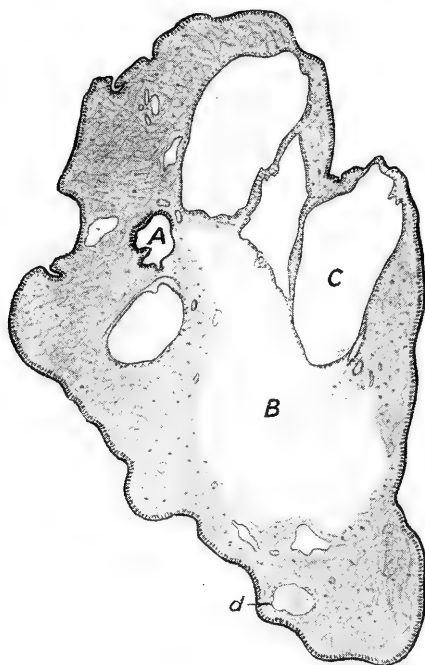
§ *The structure of the Young Plerocercoids.*

As will be seen later, the separation of these from the more advanced stage of the sexless worm is purely arbitrary. But, as there is an hiatus in point of size and general appearance, it is convenient to treat of them alone.

I use the term "Plerocercoid" in the loosest way, for an immature tapeworm which can be referred to neither the *Cysticercus* nor *Piestocystis* type. Indeed it cannot be referred with

more exactitude to the *Plerocercus* type, but perhaps on the whole is nearer to that type than to the others. The fact is that the present form and, for the matter of that, the long known *Cysticercus fasciolaris* necessitate the revision of the nomenclature of the immature Cestodes. I do not, however, propose such a step in the absence of full knowledge of the present genus, *Urocystidium*, and therefore adopt temporarily the term *Plerocercoid*. It is I think generally held that the name *Piestocystis*

Text-figure 2.



Transverse section of larva which is figured entire in text-fig. 1, *E*.

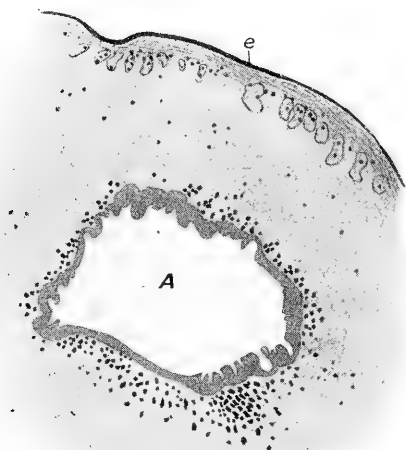
A. Cavity surrounded by gland-cells. *B*. Bladder-cavity. *C*. Third kind of cavity perhaps derivable from *A*. *d*. Tubes of water-vascular system.

should be applied to those "bladder" worms in which the cavity of the bladder is filled up to a greater depth with parenchymatous tissue, thus leaving the central cavity comparatively small and surrounded by very thick walls. On the other hand, *Piestocystis* might be converted into the *Plerocercus* type by the complete obliteration of the bladder cavity. An apparently intermediate condition is recorded by Max Braun in his account of the Cestoidea in Bronn's "Thierreich," in which (*Cysticercus*

sphaerocephalus Rudolphi) the bladder is divided up by trabeculae. *Urocystidium* is not definitely of any of these types.

Text-figure 2 represents a transverse section through about the middle region of the youngest of the two individuals which I have studied. In this region the worm is at its broadest; there is no question of a posteriorly situated bladder, as in the complete immature worm which I described and figured in my former paper. The diameter is at most 2.5–2.8 mm. The parenchyma is interrupted by numerous oval to circular and more elongated cavities which occupy the greater part of it. These cavities vary in number and size in different regions. The largest number

Text-figure 3.



Portion of a transverse section near to that represented in text-fig. 2, but more highly magnified.

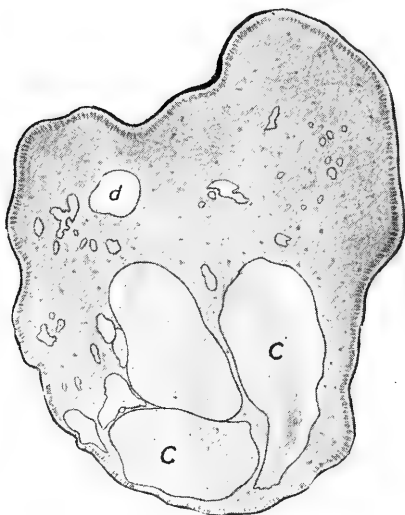
e. External surface showing cuticle and subcuticular layer. *A.* Cavity lined by cuticle, outside which are cells, and corresponding to cavity *A* in text-fig. 2.

that I have counted in a given section is 17; the smallest number—and this occurred only at the two ends of the body—is 1. I have found no direct relation between the width of the body and the number of cavities; that is to say, the cavities are more numerous at one end of the body, which measured only 2 mm. in diameter, than in the section figured, which measured nearly 3 mm.

But although there is no direct relation of this kind, it is a fact that it is only at one end of the body that the cavities are most numerous. This may possibly, for reasons which will be apparent

later, be termed the anterior end. But although there are facts which point to the view that this is the anterior end, there appears to be no difference in minute structure between the two ends of the worm. There is not even the rudimentary scolex marked chiefly by its pigmentation, which I referred to in my earlier description of the sexless form of this worm. The cavities which occupy so much of the inside of the body can be referred to four categories, and their differences are rendered clear in text-figure 2. The cavity lettered "A" is distinguished from the others by the structure of its walls. It is lined by a structureless layer (see text-fig. 3) which quite resembles the external cuticle of the worm. Round this cuticle are stalked

Text-figure 4.



Transverse section through the same larva as that represented in text-fig. 1, *E*, in a place where the cavities C only are to be seen.

d. Water-vascular tubes.

glandular cells which are quite like those of the subcuticular layer. These cells are very conspicuous, as is shown in the figure. The cavities are the expression in transverse section of tubes which are short and do not branch so far as I could discover. The obvious similarity to the external layer of the body which they show led me to expect that an opening or openings on to the exterior would be found. I have not, however, obtained perfectly satisfactory evidence of such, and indeed have found no actual orifice at all. In the case of one of these tubes, which I

followed out from beginning to end, the tube became connected at one blind extremity with the outer layer of the body by a scattered group of subcuticular cells. This as it appears to me may represent a previously existing pore. As I possess no younger example of the plerocercoid than the one described here, this point cannot be settled. Cavities having the character just described are few in number and are not always to be seen in a given series of sections. The letter B in text-fig. 2 points to a cavity of a completely different character from that which has just been described. This cavity is always single, and by following out its course there is seen to be only one of this nature in the whole body. Furthermore, it does not traverse the whole body but is restricted to the hinder end (as I have termed it), and does not nearly extend to the end which is occupied by the numerous cavities of the third character (*cf.* text-fig. 4) to be shortly described. The cavity is median in position and occupies about three-elevenths of the entire length of the worm's body. It occupies the last third of the worm but does not by any means extend to the very end. This cavity is not marked off from the surrounding solid tissues by any definite wall. On the contrary, in certain places at least the appearance is as if the tissues had gradually become broken down at the edge to form this central cavity. It fact it seems to me to be fairly certain that this is the true bladder-cavity, which agrees in most particulars with the bladder-cavity of such a form as the *Piestocystis* from the snake *Hoplocephalus superbis*, described by Prof. J. P. Hill*, concerning which that author writes †:—"The bladder-cavity in this form is represented by an irregular cavity occupying the centre of what represents the caudal bladder of ordinary *Cysticerci* and not distinctly marked off from the surrounding ground-tissue. The cavity is filled by a granular material consisting of a homogeneous matrix with granules which stain deeply with cochineal, and which represent the products of degeneration of the original central tissue." I am therefore disposed to compare and regard as equivalent these spaces in the two immature tapeworms, and to consider, as a consequence of this comparison, that the area in *Urocystidium* which is occupied by the space in question is the hinder end. There is, however, as I have already intimated, no confirmation of this view by the discovery of a scolex. The cavities lettered "C" next require attention. These cavities vary greatly in size, but are never so large as the bladder-cavity already described. They are either absent or if present necessarily peripheral where the bladder-cavity is at its largest, and often come to lie close under the subcuticular layer of the body-wall of the worm. Hence the clear spherical cavities discernible in the living worm and duly referred to above.

These cavities, however, contain no trace whatever of any

* "A Contribution to a further knowledge of the Cystic Cestodes." Proc. Linn.¹ Soc. N.S.W. (2) ix. p. 49.

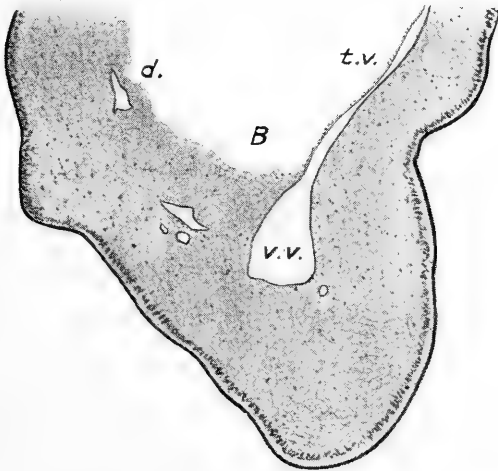
† *Ibid.* p. 52.

budding scolices. They generally appear to be empty ; but traces of an apparently coagulated fluid are to be observed after deep staining with hæmatoxylin. They have invariably well defined edges, and thus cannot be confused with the true bladder-cavity as I assume it to be. In the section which is represented in text-figure 2, these larger spaces with their well defined walls are plainly to be distinguished from the space lettered A in that figure with its lining of membrane and outer coat of glandular cells. The difference is most striking and is accompanied also by a difference in size which is apparent in the same drawing. I am not, however, convinced that there is a real difference. For some of the cavities in question show distinctly a layer of cells immediately outside of the cavity, and traces of a thin membrane within that are to be noted. An expansion of such a tube as is represented in A of text-figures 2 & 3 might well lead to such appearances by a stretching of the lining membrane and by the pulling apart of a close layer of cells. On the other hand, some of the cavities lettered C (see text-fig. 4) are undoubtedly without a distinct layer of cells around them. But here again the continued expansion and perhaps the degeneration of the cells, if they are concerned with the production of the fluid within the cavities, may have produced such a result. As I have no younger stages than that of which I am now giving the description, the matter does not as I think admit of a more definite expression of opinion. The most careful examination has not shown any connection between these cavities ; they are quite isolated as far as I could make out ; and if connections occur they cannot be abundant. Nor were there any orifices on to the exterior to be observed. I followed out through a series of sections the course of more than one of the cavities and could find no outlet from their interior in any direction. There is, however, some evidence, though not very strong, that they are formed out of the original bladder-cavity. When the latter is carefully followed up to its anterior end (as I have called it for reasons given), the cavity is seen to acquire walls like those which surround the numerous cavities lying beyond its anterior end. It ends in fact in what looks very much like one of the cavities lettered C. But this cavity does not end in the parenchyma or in connection with one or more of the rounded spaces just described. It is seen to lie within one of the latter cavities and to end in it without opening into it. But we may have here the last remaining vestige of such a connection as has been suggested. Here again the absence of younger stages forbids a more definite statement.

The last series of cavities are those lettered *d*. These are undoubtedly the tubes of the water-vascular system and are peripheral in position. It is, however, to be noted that these tubes and spaces do not invariably, though they do generally, lie outside of the cavities belonging to the category C. The water-vascular system consists partly of irregular spaces of a tubula

character, which occasionally end below and in contact with the cuticle covering the body externally. I have not, however, observed any actual pores on to the exterior. I have also found the principal longitudinal vessel, which is the ventral vessel, as I judge, of the completely developed sexless worm. I believe this to be the case, since a transverse vessel arising from it was occasionally (see text-fig. 5) quite plainly to be recognised. I could not, however, find any continuous dorsal vessel lying to the inside of this, such as is very obvious in the later stage of the plerocercoid to be described immediately.

Text-figure 5.



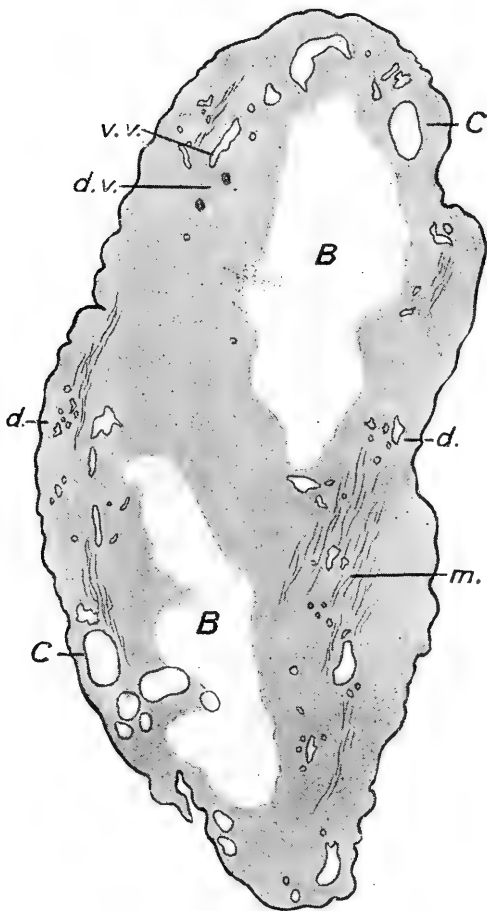
Part of a transverse section of the same individual.

B. Bladder-cavity. *d.* Water-vascular tubes. *t.v.* Transverse water-vascular tube. *v.v.* Ventral vessel.

The larger specimen, which was examined by means of longitudinal sections, showed no great differences of structure from the smaller individual. The same four systems of cavities were distinguishable and presented the same characters. The spaces *C*, as shown in the accompanying text-figure (text-fig. 6), are in form roughly spherical and hardly at all elongate. They seem to be, on the whole, actually smaller than in the younger stage, which argues commencing disappearance, or rather reduction; for, as will be seen later, these various spaces are quite recognisable in the completely developed and budding asexual worm. The bladder-cavity (*B*) seemed to me to be rather larger in proportion as well as actually than it is in the younger plerocercoid; and one would of course have expected the contrary. It is, however, not

unreasonable to suppose that there are variations in the degree of progress of the reduction of this cavity. As before, the cavities A and C are chiefly at the two ends of the worm.

Text-figure 6.



Longitudinal section through larva figured in text-fig. 1, D.

d.v. Dorsal water-vascular tube coiled and therefore seen cut across in several places.
m. Longitudinal muscles.

Other lettering as in text-figs. 2 & 5.

The water-vascular system (spaces lettered *d*) is more fully developed in this older plerocercoid, and it differs from that of the younger example in the presence of a perfectly distinct dorsal vessel

with very muscular walls, in addition to a much larger ventral vessel. These are shown of the correct relative size in text-fig. 6, *d.v.* & *v.v.* The branches of the ventral trunk which connect the two ventral vessels of opposite sides of the body open as I have described in the older worm, by two branches into the ventral vessel. The transverse trunk traverses the bladder-cavity and is surrounded on its transit by a layer of tissue which here, as elsewhere, shows the commencing obliteration of the bladder-cavity. In this worm the longitudinal and transverse muscular layers of the body were very evident, and the worm was much pervaded by calcareous corpuscles. The latter were often grouped a few together in sacs not far below the subcuticular layer. I shall recur to these in considering the structure of

§ *The Fully-developed Plerocercoid.*

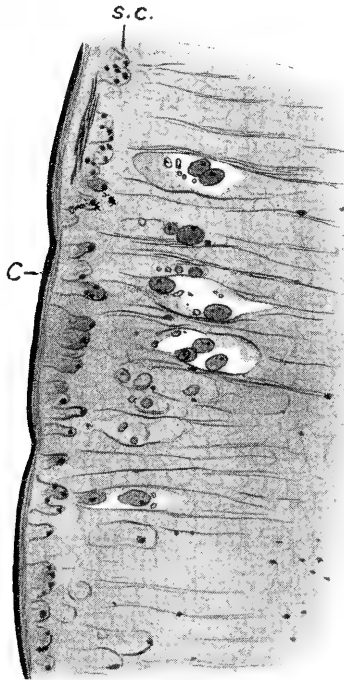
In my former paper upon *Urocystidium* I gave some account of the general structure of the sexless worm which bears the buds. I have now a few additional remarks to make upon this stage. Text-fig. 7 represents a portion of a cross section to illustrate the inclusion of groups of calcareous corpuscles in cavities below the subcuticular layer. The corpuscles contained within are both larger and smaller, and there is also some granular detritus. The cavities themselves are rather elongated, but are always separated by muscular fibres running between them and at right angles to the longitudinal axis of the worm's body. I have not studied the development of these cavities. I refer to them for two reasons. In the first place, the existence of quite similar agglomerations of calcareous corpuscles in the younger plerocercoid is one of the arguments which lead me to regard the various stages which I am now describing as being actual stages in the development of this worm—as forming a true sequence in the order which I have indicated. In the second place, these sacs of calcareous bodies are to be compared, as I believe, to apparently similar structures recently described by Prof. J. P. Hill*. The figure† given by that author agrees very closely with that appended to the present paper (text-fig. 7), and the worm with which he deals is a *Piestocystis* stage, which thus agrees with the present species in some other particulars, though, as already stated, I cannot definitely refer the asexual stage to the *Piestocystis* type. The investigation of the younger worms allows of an explanation of certain structural peculiarities in the older worm which I was unable to understand while preparing my former paper. There is, I think, no doubt that the central cavity is, as I then suspected, an extension forward of the cavity of the bladder, which we now know to be not limited to one dilated end of the body in the young of this species of tapeworm. The elongated worm-like

* "A Contribution to a further knowledge of the Cystic Cestodes." Proc. Linn. Soc. N. S. W. (2) ix. p. 60.

† *Ibid.* pl. iii. fig. 6.

asexual form is therefore in reality a bladder-worm, and not an adult in which sexual organs have not yet appeared.

Text-figure 7.



Section through skin of the fully developed asexual worm.

C. Cuticle. s.c. Subcuticular layer below which are the sacs containing calcareous corpuscles.

Furthermore, it is to my mind evident that the "closed cavities of very problematical nature" which occur in the fully-developed sexless worm, which it will be remembered are not segmentally arranged and which have a lining of cuticle and epithelial cells, are the cavities lettered A and C in my figure (text-fig. 2) of the young plerocercoids. In addition to these there are various tubular cavities which seem to belong to the water-vascular system, and which I observed to approach very closely to the exterior of the body but not to open thereon. These tubes, present in addition of course to the four longitudinal trunks, are exactly repeated in the younger stages that have been described in the present communication. There is therefore no abrupt break between the much more bladder-worm-looking embryos

and the completely formed sexless worm; the metamorphosis is obviously a matter of gradual growth. The question next arises as to what is the relation of the complete plerocercoid to the adult tapeworm. Is the one converted into the other? To settle this matter, or rather to contribute to its settlement, we must again consider the buds produced by the sexless worm.

But I shall first make a

§ *Comparison of Immature Urocystidium (fully developed Plerocercoid) with Cysticercus fasciolaris.*

In my earlier paper upon this worm I compared these two forms in certain details; but the description was concerned with external characters alone. Now that I have been able to ascertain some more facts about the development of the asexual form, a more detailed comparison will be made. My information as to *Cysticercus fasciolaris* is chiefly derived from Bartels's memoir cited below*. Although a primary difference of great importance absolutely separates the two immature forms, it is rather remarkable that the number of hooks in the *Cysticercus fasciolaris* seems to be identical with that of the sexually mature *Urocystidium*. Bartels gives 34–36 hooks, arranged, as they are in the present species, in two circles. But though this statement is made in the text, only 16 in one row are figured by him, and, moreover, in two different figures†. This is the number that is met with in the adult *Urocystidium*. In the immature form, as I have mentioned, there is no trace of hooks that I could discover. In both forms the calcareous corpuscles are very numerous. But while in the present species these corpuscles are most numerous in the sexual form, the reverse is the case in *Cysticercus fasciolaris*, the mature worm, *Tænia crassicolis*, having fewer calcareous bodies. The most noteworthy resemblance seems to me to lie in the disposition of the bladder of the two worms. In the *Cysticercus* the bladder is situated at one end of the body, and is very small compared with the free and segmented portion of the worm. As I have already pointed out, precisely the same is the case with *Urocystidium*. But in both cases the cavities found in the worm are not limited to a restricted bladder. Cavities occur in both in the segmented part; these are in *Cysticercus* mainly limited to the posterior end of the body, but they are also found anteriorly; so that there is here no essential difference from *Urocystidium*. Bartels remarks of these cavities that they are some of them connected with the bladder-cavity while others are cut off from it. He mentions that these cavities are sharply marked off from the parenchyma in which they lie, but that they cannot be said to possess definite walls. There is thus a greater resemblance to the bladder-cavity of the buds of *Urocystidium* than to that of

* Zool. Jahrb. Bd. xxi. 1902, Abth. f. Anat. p. 511.

† Loc. cit. taf. 39. fig. 21 & taf. 38. fig. 15.

the developing asexual worm which arises, as I suppose, directly from the egg. There is, however, clearly a general resemblance to the latter, and, as I think, an important resemblance.

The cavities also contain in both the immature Cestodes now under consideration a coagulable fluid apparent on staining. The tubes of the water-vascular system are much alike in the two worms. In both the dorsal vessel is the smaller and has a thick muscular wall; while the two worms also show resemblance in the fact that the transverse vessels which run across the segments arise by two origins from the larger ventral vessel. This detailed likeness is very striking. In spite of these points of likeness there are numerous points of difference between the two species. *Cysticercus fasciolaris* would seem to show no such specialisation of the bladder-cavities, or at any rate no such variation of structure in the cavities found in its interior, as does *Urocystidium*. The total absence of hooks, and indeed of a well-marked scolex, in *Urocystidium* has been already commented upon. The *Cysticercus* under consideration agrees with other *Cysticerci* in differing absolutely from *Urocystidium* in these features. Dr. Bartels heads one section* of his memoir upon *Cysticercus fasciolaris* as follows:—"In welcher Beziehung stehen *Cysticercus fasciolaris* und *Tænia crassicolis* zu einander betreffs der Höhe ihrer Organisation?" The same query might well be asked concerning *Urocystidium*. In the former case the only differences are in the disappearance of the traces of the bladder, the appearance of the gonads, and, apparently, the slight increase of the number of hooks upon the scolex. The general level of organisation is upon precisely the same level in the two stages of development. The latter statement can well be made of *Urocystidium*. Transverse sections of the sexual adult and the completely developed immature stage, which are shown in my earlier paper upon this worm, leave little structural difference between the two forms save the two features in which the *Cysticercus* differs from its *Tænia*. The only important addition to be made is of course the absence of a scolex in the young *Urocystidium*. It was, in fact, not merely the equality of organisation but also the details of likeness which led me to assume originally that the one form of *Urocystidium* was really a stage in the development of the other. So far as is known, these two forms are the only ones among the higher Cestodes in which there is a high grade of organisation in the sexless stage. And it is perhaps this general fact of likeness which tends to impress upon one the further points of likeness between this form and *Cysticercus fasciolaris*, and to diminish the really important points of difference already referred to. As to further development, Bartels is of opinion that the *Cysticercus* develops into the *Tænia* with no further change than the loss of the bladder.

* *Loc. cit.* p. 542.

§ *Comparison of the Young Plerocercoids with the Buds.*

As has been already observed, there are no free living stages of this worm in my possession which are younger than the specimens described in the foregoing section. But it has also been suggested as a possibility that the buds formerly described by me may be a stage antecedent to those which I have termed the young plerocercoid. When freed from the fully developed asexual worm they may drop off into the liver ducts and there increase in size—principally in breadth, for the length of the longest buds is not far removed from that of the smallest free plerocercoid—and, after a certain alteration in structure, show the characters of the maggot-like larvæ which have been dealt with in detail in the last few pages. I do not think, however, that this can be the case, failing at any rate further evidence. For the most “mature” of the buds which I studied in some detail for my earlier communication upon this genus has a much more “adult” structure than has the youngest of the plerocercoids described in the present paper. And if we are to assume that the young plerocercoids described here develop gradually into the large sexless worm, as I think is fairly certain, this possibility is rendered still less likely.

I shall now indicate the differences in structure between the plerocercoids and the buds which oppose themselves to this comparison. The various stages in the development of the buds shown in text-fig. 116* of my earlier paper seem to show that the bladder is the first part of the worm to appear and that the vermiform region is an outgrowth of this. For the buds are at first bladder-like outgrowths of the stock, and then develop a process at the free end which gets to be more important. Now in the plerocercoids the whole worm is at first also little more than the bladder region; but this is converted into the more mature individual by a proportionate suppression of the cavities which together constitute the bladder-like region, and the gradual conversion of the greater part of the worm into a more markedly vermiform body. Traces of the bladder-cavities, however, persist in the latter up to the anterior end. This difference of mode of growth does not, however, exhaust the differences observable between the two series of young worms. The bladder-cavity itself differs in the two. As already described, it has no proper walls in the free young plerocercoids, while in the buds it has not precisely a definite wall, but the inner layer is thickened and it is sharply marked off from the empty space which it encloses: it is, in fact, like some of the cavities lettered C in the young free worms.

There is, however, the tube which I have lettered α in my figure of a transverse section through a bud†, which is in structure very like the spaces lettered A in the transverse section through the young plerocercoid (text-figs. 2, 3). The former is,

* P. Z. S. 1912, p. 824.

† *Ibid.* text-fig. 116, p. 833.

however, distinctly tubular and definitely opens on to the exterior, in both of which characters it differs from the cavities described above in the young free larva. The water-vascular system presents both similarities and dissimilarities in the two. In the bud there are but two longitudinal vessels, one on each side of the body. These are connected by transverse vessels and are thus in all probability to be looked upon as ventral vessels; the dorsal, it is to be presumed, appear later. The youngest free larva also possesses only two lateral longitudinal trunks, which are for similar reasons to be regarded as ventral vessels; but it has in addition other water-vascular tubes which are completely wanting in the bud. In fact, there are no detailed resemblances such as would be sufficient to overbalance the general unlikeness between the buds and the free living asexual parasite; they do not appear to me to be stages in the same series.

§ *Origin of the Sexual Form.*

It seems to me to be much easier to believe, on the other hand, that the buds are a stage in the development of the sexual worm. But here it is only a matter of possibility or probability; there are but few facts. And these facts are mainly negative. For there are actually no more positive points of likeness between the bud and the sexual form than there are between the buds and the fully developed sexless form; but perhaps the resemblances, though few, are of a little more importance. In the first place, the solidity of the body anteriorly to the bladder, save for the one tube which runs along it, is more suggestive of the adult sexual worm, than of the sexless worm with its abundant cavities and continuous bladder-cavity. The gradual tapering off of the single cell-lined cavity, which the buds possess, as it approaches the anterior end of the body, indicates the ease with which it may vanish altogether. In the second place, the bud shows no series of peripheral tubes which I have regarded, in the case of the young free worms, as a part of the water-vascular system. These are absent from the sexually mature worm. Finally, there are the aggregations of cells, of which I have spoken in my first paper upon this worm and which may be the commencing sexual organs.

This is the most important resemblance. The other features in the structure of the bud do not forbid the view which I am now supporting by such facts as are available. But they might with equal reason be urged in favour of a likeness with the free sexless stage.

There is obviously nothing decisive about the retardation in the appearance of the smaller dorsal water-vascular tube, and the fact that there are two layers of bundles of longitudinal muscular fibres in the cortex points with equal directness to the adult worm and to the complete immature worm. But the comparison here is with the *fully developed* immature tapeworm, and not with the maggot-

like earlier stages of this (if I am right in so regarding them). It would appear, therefore, that the facts which have just been referred to in the structure of the bud may be perhaps really looked upon as arguments in favour of a comparison of the bud with the fully adult sexual form and a conclusion that the former ultimately gives rise to the latter. For if we are to assume that these buds give rise to the plerocercoid, it will have to be further assumed that the regularly arranged and perfectly differentiated cortex and medulla of the bud becomes lost, only to be reconstructed later when the plerocercoid has arrived at the completion of its development. Of the alternatives, this seems to me to be the less likely. In short, I am obliged to admit that the development of the bud into the sexual worm is mainly probable on account of the difficulties which beset the view that it is an earlier stage of the plerocercoid.

§ *The Sexual Form.*

The sexual form appears to differ in several particulars from that of my first specimen of *Urocystidium gemmiparum**, and I have been able to compare the two placed side by side. It is to be noted, however, that they agree with each other in differing from the asexual worms in their browner colour. This is perhaps rather more strongly marked in the individual which forms the subject of the present communication to the Society.

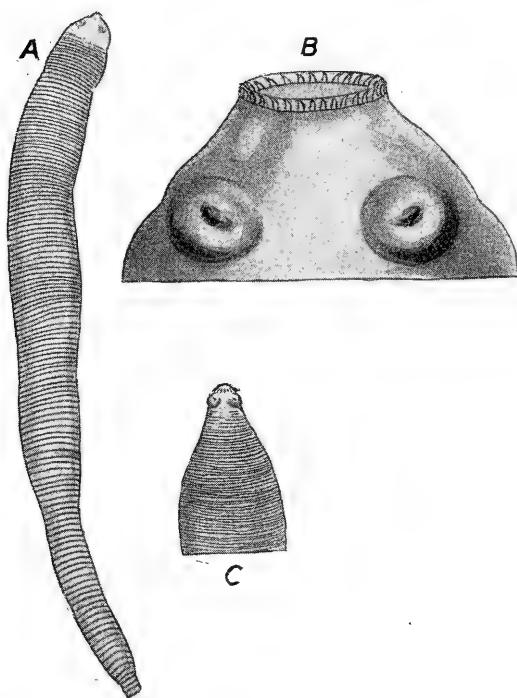
In the case of both worms, the segmentation begins immediately after the scolex and the segments are quite narrow. They get, however, slightly longer at the posterior end of the body, and in the new specimen the last three segments are comparatively long though not nearly so long as broad. The body ended abruptly with the last of these segments. The present worm contrasts with the original specimen in its smaller size; it is of about half the length, measuring some 42 mm., and is not nearly so broad, the greatest breadth being 4 mm.

It is, however, in the scolex that the most prominent difference between the two individuals is to be found. Of this region I have had drawings prepared, which are shown in text-figure 8. On a superficial view, with a hand-lens only, the scolex of the second individual is seen to be much smaller than that of the specimen which I described a year ago. This difference is heightened when the two are compared under a compound microscope. The upper right-hand figure in the illustration (text-fig. 8 C) shows that in the new specimen the scolex end is terminated by a thin collar, in which a row of setæ are imbedded forming a complete circle. A good way below this are the suckers, which are relatively small and separated from the hooks by a larger interval than that which occurs in the type example of *Urocystidium gemmiparum*. It might perhaps be held that

* *Loc. cit.* p. 841.

the differences between the two examples is due to the different state of retraction of the rostellum in both. It might be said that if we retract the rostellum of the type specimen, a collar might be formed such as is shown in the second example surrounding the depressed rostellum in which the hooks appear. While this is quite possible theoretically, it may be pointed out that the difference in size seems at first sight and without microscopic investigation too great to allow of such a comparison. This

Text-figure 8.



A. Sexual individual. B. Scolex of same with rostellum retracted.
C. Anterior end of sexual individual described in P. Z. S. 1912, p. 841.

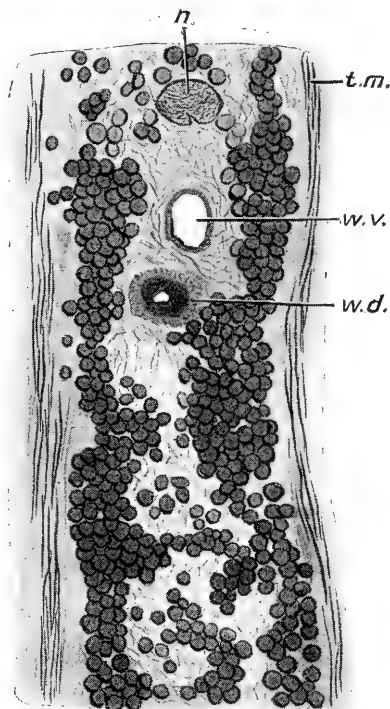
will readily be seen on an inspection of text-fig. 8, A & B, which are drawn of the correct relative size. It may also well be that the thin collar-like edge which bears the hooks in the fresh example of *Urocystidium* is a permanent structure, and that there is nothing to compare with it in the earlier example. But this point cannot of course be settled in the absence of other specimens. On the whole it would seem impossible that any differences in

the state of contraction of the two examples could account for the plain lack of resemblance shown in the various figures referred to. Moreover, the suckers are very much smaller in the new example of *Urocystidium*, and by no means so prominent as are those of *Urocystidium gemmiparum*. So much then for the scolex of this worm, so far as it can be seen by a mere inspection of the uninjured worm. I have made a series of transverse sections through the scolex after the above figures were drawn, in order to elucidate further the structure of this part of the body. In spite of the apparent differences enumerated above, I cannot find any reason after a microscopic examination for regarding this individual as referable to a second species of the genus. The hooks are disposed in two rows, the hooks of each row alternating; there are sixteen to each row and those of one row are much smaller. The apparently smaller size of the suckers is due to their complete retraction. It is very important to note how individuals may appear to differ if not examined microscopically and when in a different state of contraction.

In my original description of *Urocystidium gemmiparum* I gave a somewhat detailed account of what I then supposed to be ripe ova scattered thickly through the segments of the body, particularly towards the end of the body. I have re-examined the original sections which I made, and have cut fresh sections from the original material in order to consider the matter afresh. A part of one of these sections is illustrated in text-fig. 9. It will be seen that, as I have already reported, the medulla as well as the cortical layers is stuffed with bodies closely resembling eggs. They are large and lie loosely in the parenchyma, being often aggregated into clumps. This section was regarded by two naturalists, to whom I showed it, as being chiefly made up by these masses of what appear to be eggs. I confirm my original description as regards the structure of these bodies. They consist of a nucleated cell closely surrounded by a transparent homogeneous layer, which I noted as being the egg-shell. I did not see the nucleus in all of the supposed eggs, which I carefully examined with high powers. This matter I am able to correct by the subsequent observations upon which I report here. The nucleus is present in all of them; but often it is seen in various stages of degeneration, culminating in freedom from granules, and thus almost complete transparency. In the second example of this tapeworm, the same cells were present and no particular description of them is necessary. The occurrence of the same bodies in a second individual led me to suspect that they were not eggs; for on the hypothesis of a diceious tapeworm it might be expected that a male would be found. I had realised the likeness of these bodies to calcareous corpuscles, but had abandoned that view in deference to their immense multitude, and if anything greater prevalence of numbers in the medullary part of the body of the worm. Moreover, it is usually stated that the nucleus of the cell in which lime is deposited, and which becomes in consequence a

calcareous corpuscle, is excentric. This is pointed out by Benham* and in the investigations of v. Janicki upon the development of these bodies in the genus *Davainea*†. On the other hand, it is to be admitted that Lönnberg‡ found the nuclei to be often centric as well as excentric in the Bothriocephalid *Abothrium rugosum*. There are, however, two strong arguments in favour of regarding these bodies as calcareous bodies: these are, first, that they bubble with gas on being treated with dilute hydrochloric acid; and, secondly, that I have found in this second example of the worm rudiments of the real generative organs.

Text-figure 9.



Part of a transverse section through sexual form of *Urocystidium gemmiparum*.

n. Nerve-cord. *t.m.* Transverse muscles. *w.d.* Dorsal water-vascular tube.
w.v. Ventral ditto. The medulla is crowded with darkly stained calcareous bodies.

The second argument is I think conclusive as against the view that the bodies in question are eggs. The reproductive organs

* 'A Treatise on Zoology,' Oxford, pt. iv. p. 107 (1901).

† Arch. de Paras. t. vi. 1902, p. 261.

‡ K. Svensk. Vet.-Ak. Handl. Bd. 24, 1891, p. 78, pl. i. fig. 5.

are in all the segments which I examined quite immature; but the cord of cells representing the future ducts were quite visible and were seen to lie always on the same side. This worm therefore appears to have unilateral generative pores. This discovery renders the novelty of this worm as a genus rather more doubtful. But the facts now known do not permit of a settlement of the question. For the structure of the reproductive organs can alone, at the present day, determine the systematic position of these tapeworms. It is, as I think, unsafe to base generic identity upon other characters in the absence of information about the reproductive system. But it may be pointed out that there are undoubtedly certain resemblances in the structure of the water-vascular tubes of this worm and of *Tenia crassicollis*, which are mentioned above* in comparing the young of the two worms. But I do not think generic identity with *Tenia* proved.

§ Summary and General Considerations.

The fresh material reported upon in the foregoing pages enables me to define more fully the structure and life-history of the tapeworm which I described formerly as *Urocystidium gemmiparum* †, from *Fiber zibethicus*.

As for the general structure of the fully grown asexual generation I have nothing to add to my former description, to which reference may be made. The individual, however, which I have described and figured in the present paper, differs from that previously described in showing no development of buds. Two earlier stages in the development of the asexual worm are described in the present paper. These are plump, short, but still vermiform, and segmented, worms. They differ from the full-grown asexual worm in the greater proportionate size of the bladder-cavity and other cavities perhaps connected with the bladder-cavity. But all of these cavities persist in the full-grown asexual stage. They show no hooks or recognisable scolex. In the earliest stage there is no differentiation of the body-wall into cortex and medulla; in the more advanced young there are but feeble traces of this differentiation, quite achieved in the completely formed asexual worm.

The structure of the asexual worm as elucidated by the younger stages described in the present paper, shows that it is not referable exactly to any type of asexual tapeworm as yet described. In spite, however, of its external and internal (transverse water-vascular vessels) segmentation, it is essentially a bladder-worm, but, as it appears, without a scolex. In complication of structure and in details, this asexual stage is not far different from the sexual stage. The sexual worm, which occurs in the same cavities of the liver side by side with

* *Supra*, p. 14.

† It is to be borne in mind as possible, but not at all probable, that the two sets of worms are of different species.

the asexual stages, is of roughly the same size as the fully-developed asexual stage. It has a very strongly muscular rostellum and two rows of sixteen hooks each, the outer row consisting of smaller sized hooks than the inner. The body of the sexual worm is crammed with large oval calcareous bodies with a centrally placed nucleus. Such bodies are also very abundant, but not so abundant, in the bladder-worms. The gonads, etc. (quite immature in both individuals) are fairly central in the proglottids, and the ducts are all directed towards the same side of the body.

It would appear, therefore, that both the structure of the immature tapeworm and the series of stages by which maturity is arrived at, are quite unlike anything that is at present known among the Cestoidea. But as there are obvious lacunæ in the information which has been set forth in the present paper, some uncertainty attaches to the life-history the course of which is suggested by those facts. There are, as it would appear, two larval stages following each other and derived from each other directly. From the egg (as I presume in the absence of earlier stages) arises the larva which I have described as a plerocercoid; this gives rise by budding to many larvæ which differ in several structural features from the asexual parent; these (and here there are no positive facts but only inference) give rise to the sexual worm. There are thus three stages in the life-history of this tapeworm which are not met with in other Cyclophyllidea, except as mere multiplication as in *Echinococcus*. *Bothriocephalus* has three distinct stages, but they are not comparable to those described here, since the first is a free-swimming ciliated larva. The complication of the life-history in this form is suggestive, of course, of the Trematoda; but I can make no detailed comparison.

2. Observations made to ascertain whether any Relation subsists between the Seasonal Assumption of the "Eclipse" Plumage in the Mallard (*Anas boscas*) and the functions of the Testicle *. By C. G. SELIGMANN, F.Z.S., and S. G. SHATTOCK.

[Received December 20, 1913 : Read February 17, 1914.]

(Text-figures 1-6.)

INDEX.

Physiology and Variation.

The observations herein set forth were made with the object of ascertaining whether any relation exists between the condition of the testicle and the seasonal assumption of the eclipse plumage in the male of the Wild Duck or Mallard (*Anas boscas*). Although the seasonal changes are well known and were fully described many years ago by Waterton, with whom the term "eclipse" originated †, it does not appear that any observations have been made on the condition of the testes accompanying the change.

What we wished to determine was, whether the assumption of the male plumage corresponded with the advent of spermatogenesis, and whether the occurrence of the "eclipse" is associated with retrogressive changes in the sexual gland.

We may point out that the interest attaching to this question is increased if the pairing habits of the wild duck and some other common birds be considered. The cockerel of the common fowl, for example, is sexually potent as soon as its external characters are declared (so that poultry breeders are careful to separate the cockerels from the pullets as soon as the former begin to show male plumage), but in the pheasant, although full male plumage is assumed in the autumn, no pairing (or any manifestation of the sexual instinct) takes place until the spring. In the wild duck the birds pair in the autumn or early winter, after the male assumes full plumage, but copulation does not occur until the spring is advanced.

Our observations fall into two series :—

1. Simultaneous observations on the plumage and the condition of the testes in a series of Wild Ducks throughout the year.

2. Observations on Wild Ducks from which the testicles have been removed.

* The expenses connected with this work were defrayed by a grant from the Royal Society, London.

† W. Yarrell, 'History of British Birds,' vol. iii. p. 175.

I.

Observations on the plumage and the condition of the Testes.

These were made on domesticated wild ducks such as are found in the London parks and supplied from game-farms. These birds are commonly slightly larger than those really wild, but they pass through the seasonal changes of plumage in approximately the same period, and appear to vary in the time (season) of their change no more than do wild birds from England and Scotland respectively. We were able to examine a few really wild birds caught in decoys in January and February, and found no substantial difference in the condition of their testes and that of those domesticated, but we did not extend these observations, since it appeared probable that the confinement of such birds might lead to abnormalities in the onset of their plumage changes, and even affect the condition of their reproductive glands.

Before dealing with the changes in the plumage and in the sexual glands of adult birds, it will be well briefly to summarize the conditions found in young or immature birds, by which we mean birds of the year, that have not yet assumed full plumage. So defined, the period covers the first five to six months of the bird's life and ends in November or December. In the young birds the nestling plumage persists until at least the middle of September, about which time a few speckled feathers appear on the legs and shoulders, the breast and belly being still unchanged. By this time the full complement of flight-feathers has appeared, but the feathers themselves are usually not more than half grown. The testes of such birds are usually quite small, measuring on an average about 10 mm. in length and about 2 mm. in breadth; they are firm on section, and yellowish brown in colour. Under the microscope the tubuli are found to be small, and with a relatively narrow lumen lined with a single layer of cells, between which certain larger spheroidal spermatogonia are intercalated. In some the cells are two deep. The interstitial stroma is very cellular, and, contrasted with the condition found in the fully functional gland, it appears relatively abundant*. There is a good deal of individual variation in the external appearance of the birds at this time, even a few days making a considerable difference. The growth of the birds and the development of the plumage proceed rapidly during October, so that by November the drakes have attained their full size, and have assumed their perfect plumage. The testes become larger and yellowish white

* We may refer here to the appearance presented by the testes of a freshly-caught wild Mallard killed during the last quarter of December. This bird weighed 1 lb. 14 $\frac{3}{4}$ ozs.; its testes, which were firm, yellowish in colour, and dry on section, together weighed 88 mg. Microscopic sections showed the tubuli to be of small size, with narrow lumen, lined with a single or double row of cells, and with larger spermatogonia occasionally occurring between the basal cells. There was no sign of spermatogenesis.

in colour, as well as softer, but no juice exudes on section, and spermatozoa are absent. At this time of the year, *i. e.* at the end of November and December, there is no marked and constant difference between the testes of the young birds of the year that have but just assumed their winter plumage for the first time, and the testes of older birds that are passing into their full plumage for the second or third time. But since our observations lead us to think that the changes in the testes may take place rather more rapidly and regularly, and perhaps a little earlier, in the older birds, we confined our observations to birds which had passed through at least one full change of plumage.

In order to make clear the significance of the plumage-changes in normal and in partially castrated adult birds, recorded below, we may give a summary of those which naturally occur in the male wild duck.

Normally in the adult Mallard (*Anas boscas*), which, it is assumed, has bred early in the spring, the curly tail-feathers are lost, and the moult of the body-feathers begins late in May or early in June. By the beginning of July the assumption of the dusky, summer, or "eclipse" plumage should be tolerably complete, though the moult of the flight-feathers has not, as a rule, begun, these being lost usually by the middle of the month. The eclipse plumage persists throughout August, during which month the Mallard, the Duck, and the young are externally very much alike. By the middle of September the curly feathers have usually appeared in the tail of the Mallard, and the bird passes from its summer to its winter plumage, which does not, however, reach its full beauty until about midwinter.

The period of the year at which the plumage changes take place varies with the latitude. In the British Museum (Natural History) there is the skin of a bird in full male plumage with curl feathers in the tail, which was killed at Shanghai (lat. 31° N.) on August 28th, 1884. The skin of another bird, killed on December 11th, 1879, at Nagasaki (lat. 33° N.), is in partial eclipse, with many brown feathers on the vertex, and eclipse feathers in the breast; while the skin of a third bird, from Wuhu, on the Yangtze, killed in January 1885, has similar, but less well marked, remains of the eclipse plumage on the breast and head.

A Table showing the condition of Plumage and that of the Testicles at each month of the year.

January 30th. Full winter plumage.

Weight of both testes, 3850 mg.; each gland is about 23 mm. in greatest length, of a yellowish-white colour and soft; fluid can be scraped from the cut surface, but it does not ooze naturally.

(In a bird killed January 23rd, the testicular tubuli were small; with well-defined lumen; cells about two deep; no spermatogenesis.)

February 14th. Full winter plumage.

Testes soft, 15 mm. in length. Tubuli large and full of well-conditioned cells, but there are no spermatozoa or spermatids. Small groups of finely granular interstitial cells are present.

February 14th. Full winter plumage.

Each gland is about 15 mm. long by 9 mm. in breadth, the tubuli are full of cells but contain no spermatozoa.

March 7th. Full winter plumage.

Weight of both testes together, 5800 mg. Testes equal in size, bean-shaped, maximum diameter 25 mm. Tubuli thickly lined with cells; a moderate number of spermatozoa in some tubuli, *i. e.* spermatogenesis is in progress.

March 16th. Full winter plumage.

Weight of testes 9150 mg. Tubules of full size, occupied by dense masses of cells; centrally there are numerous spermatozoa.

(The testes of another bird, killed on the same day, together weighed 10,170 mg.)

March 22nd. Full winter plumage.

Testes together weighed 32,500 mg. Each was as large as a pigeon's egg. Tubules of full size; typical picture of active spermatogenesis.

April 20th. Full winter plumage.

Testes large, about 50 mm. long; and so soft as to be almost diffuent on section: total weight, 30,140 mg. Spermatogenesis in active progress.

May 7th. Full winter plumage.

Total weight of testes, 30,580 mg. Macroscopically and microscopically they resemble those of the bird killed on April 20th.

May 30th. Full winter plumage.

Testes size of a haricot bean; the tubuli are distended with cells, and contain large numbers of spermatozoa. The organ is, however, retrograding, as appears from the absence of spermatid sheaves, and the fact that the spermatozoa in the centre of the tubules are badly stained.

May 30th. Full winter plumage.

Each testis, not larger than a small haricot bean, about 11 mm. long and 7 mm. broad. Tubuli, not of full size; there is a central area of vacuolated substance in which there are somewhat thinly scattered cells. No mitoses and no spermatogenesis; the whole appearance is one of inactivity.

June 6th. Full winter plumage.

Testes narrow and firm, about 13 mm. long by 4 mm. broad. Tubuli of somewhat small size, each with a peripheral layer of cells; the centre of the tubuli occupied by a vacuolated material in which cells are thinly scattered. There are no spermatozoa, but very fine deeply stained granules of chromatin occur in moderate numbers in the centre of the material (chromatolysis).

July 4th. Bird in almost full eclipse.

Testes oval, about 6 mm. in transverse diameter, pale yellow in colour, and firm on section. Tubuli small with well-defined lumen. Cells for the most part two deep. No spermatogenesis.

July 8th. Full eclipse.

Testes small, scarcely 10 mm. long by 5 mm. broad. Tubuli of comparatively small size, furnished with well-developed lumen. Cells two and three deep. No spermatozoa.

July 12th. Full eclipse.

Testes about 20 mm. long by 12 mm. broad; weight of each gland about 3700 mg. Tubuli of fairly large size, no lumen. Cells in the centre of the tubuli are small. Here and there the sheaf arrangement of spermatids is indicated, but the nuclei are mostly badly stained. No properly stained spermatozoa.

July 12th. Full eclipse.

Testes resemble those of preceding; no spermatozoa to be seen. Weight of testes together, 6560 mg.

August 17th. Full eclipse.

Testes small, diameter of transverse section 4 mm. Tubuli small, stroma relatively large in amount. Tubuli furnished with well-defined lumen, cells about two deep. No spermatogenesis.

August 21st. Eclipse.

Testes small, about 5 mm. in transverse diameter. Tubuli narrow, quite inactive. A single layer of peripheral cells; a narrow lumen; no trace of spermatozoa.

September 14th. Eclipse passing off.

Testes about 7 mm. in transverse section; weight 195 mg. Tubuli of small size, with a narrow central lumen lined with one or two layers of cells; no signs of spermatogenesis.

(In a bird killed September 13th, the testes were 6 mm. in transverse diameter; the tubuli of fair size, and filled with loosely aggregated cells; no spermatogenesis.)

September 30th. Eclipse passing off.

Many young feathers of winter plumage coming through on breast and abdomen.

Testes small, firm, somewhat brown, about 12 mm. long and 3 mm. broad. Tubuli of medium size, with central lumen; lined with cells averaging two deep.

September 30th. Full winter plumage.

Testes small, firm and somewhat brown, about 12 mm. long, but scarcely 3 mm. broad. The tubuli are of medium size only, and are filled with cells.

October 9th. Full winter plumage.

Tubuli of medium size and filled with cells. Spermatogenesis is not in progress, but amidst the central cells there appear here and there a few rod-

like bodies, apparently obsolete spermatozoa, possibly the residues of a previous state of activity.

October 25th. Full winter plumage.

Testes 15 mm. in chief diameter. Tubuli of medium size; furnished with a layer of basal cells, central to which lies a mass of cells filling the lumen of the tube. No spermatogenesis.

October 27th. Full winter plumage.

Testes about 15 mm. in longer diameter. Tubuli small, a narrow lumen in most. Cells averaging two deep. No spermatogenesis.

November 1st. Full winter plumage.

Testes 12 mm. in longer diameter. Tubuli narrow, with fine lumen. No spermatogenesis.

November 7th. Full winter plumage.

Testes about the size of a haricot. Tubuli of medium size; full of cells; no lumen; no spermatogenesis; some mitoses in the more central cells.

November 17th. Full winter plumage.

The testes fairly firm, exuding no fluid on section; together they weighed 520 mg. Tubuli of medium size; full of cells; no lumen; no spermatogenesis.

November 28th. Full winter plumage.

Testes yellowish; exuded no juice on section; weighed together 720 mg. No spermatozoa. Tubuli small, well-defined lumen. Cells average two deep.

December 6th. Full winter plumage.

Both testes of medium size, and showing active mitosis.

From the foregoing table, which details the condition of the testes in a series of birds examined throughout the year, and the state of their plumage, the following summary may be made:—

The testes attain their maximum size during the breeding-season, *i. e.* at the end of March or beginning of April. At this time each gland is almost as large as a pigeon's egg, and so soft as to be nearly diffuent on section, while the juice which exudes contains enormous numbers of spermatozoa. Although this condition is more or less maintained during the first half of May, by the end of that month the glands present a very different appearance. *Although the birds are still in full winter plumage, the testes have shrunk to the size of a haricot bean*; no mitotic figures are encountered in the cells of the tubuli, and spermatogenesis has ceased; or, if any spermatozoa are to be found, these are badly stained and obsolete. During June the glands become smaller and firmer, and the whole microscopic picture is one of inactivity; they diminish still further in size during July and August, and acquire a yellow or brownish colour. This condition persists throughout September, during which month the bird

puts off the eclipse for the winter plumage. *During October and November, when the brilliant plumage is fully declared, the testes increase slowly in size, although they remain of a yellow or brownish colour, retain their firmness on section, and exude no fluid when incised. Spermatogenesis does not commence until December (perhaps the end of November); and the testes at first do not greatly increase in size. There is some variation as to the precise time at which spermatogenesis begins, but in any case the bulk of the testes greatly augments during the latter half of January and February. Evolution proceeds more and more rapidly during the second half of February, and March, until by the end of the latter month, or during April, the glands attain their maximum size.*

It must be understood that in the above account we have endeavoured to give an average picture of the annual evolution and involution of the testes, but there is no doubt that a considerable range of variation obtains in the time of the onset of spermatogenesis. Furthermore, in some birds, spermatozoa may be found in the testes at a somewhat later date than is usual; in such circumstances it is probable that spermatogenesis arose correspondingly late.

II.

Observations made to study the results of Castration upon the Plumage.

It was our intention to castrate a series of ducks in order to see whether any aberrations would result in the natural history of the plumage, but in spite of repeated attempts, it was found impossible to completely extirpate the glands. Every visible trace might be removed, after an extensive laparotomy, and yet, when the bird was killed some months later, a greater or lesser amount of regenerated testicular tissue was found either in the normal position or engrafted upon the neighbouring organs. The castration in every case was carried out under an anæsthetic.

The following experiments should all be read in the light of this fact, viz. that some regeneration of testicular tissue must have taken place within a few weeks or months of the operation; and since we do not know how small an amount of this tissue may be sufficient to exert an action on the body, we cannot say whether the results observed within the first few months of the operation would have persisted had the castration been complete. There are, however, certain considerations which lead us to believe that our results, in so far as they apply to the first six or eight months after the removal of all visible testicular tissue, are essentially comparable with those which would occur during this time were it possible to obviate the partial regeneration of the gland. In the first place the delay in the assumption of the eclipse in the birds submitted to operation from December to April (when the plumage is masculine), indicates that the removal of all visible testicular tissue has produced a definite effect on the bird;

whereas castration performed in July, while the testicles are retrograding and the bird is in eclipse plumage, produces no corresponding delay. Furthermore, the small size of the "grafts," or regenerated tissue, in birds killed from nine to ten months after operation, would indicate that the amount of testicular tissue, regenerated, and exerting its influence on the bird during the early months after the operation, must have been extremely small.

Our observations fall into two series according as the testes were removed, (A) while the bird was in full winter plumage, or (B) during eclipse.

(A.) The Results of Castration when performed on Birds whilst in full Winter Plumage.

(No. 18.) (Text-fig. 1.) Bird in full winter plumage; castrated in December 1906. The testes removed showed active mitosis and spermatogenesis in many tubuli.

June 9th, 1907.—Bird in full plumage, with glossy vertex, and one very glossy feather in tail*. The only sign of approaching eclipse is a slight brownish-yellow tinting of some of the speckled feathers on the belly.

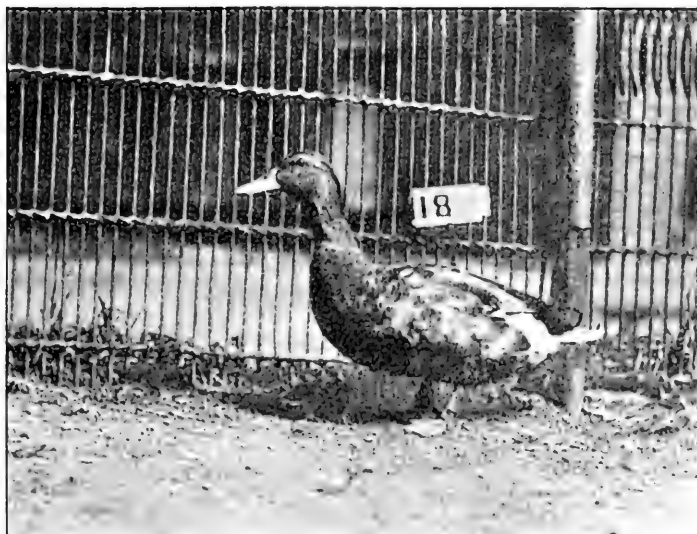
July 11th, 1907.—Full plumage unmodified except that there is a diffuse light brown coloration of the abdomen: this is not due to any growth of new feathers but to a pigmentary modification in the old. There are two curl feathers in the tail and a third forming.

July 28th, 1907.—The general appearance of the bird is still that of a male in full plumage; and the white ring on the neck is as marked as ever it was, but there are a few brown feathers on the cheeks (first noticed on July 23rd), and a strong flush of eclipse feathers in the maroon area on the breast, which is becoming somewhat lighter in colour. A number of eclipse feathers are obvious upon the abdomen; these are mostly old feathers in which pigment changes have taken place; the great majority of feathers on the abdomen are still vermiculated. There are a few new eclipse feathers in the scapular region. The tail contains two curl feathers and one partially curled.

August 1st, 1907.—Eclipse progressing very slowly; the head is in much the same condition as it was when last noted. The breast has perceptibly lightened, light brown feathers barred with black alternating with the dark maroon feathers; a few typical eclipse feathers are coming through the down of the breast. The scapulars have somewhat darkened, and there are more barred feathers upon the flank, each showing up as blotched with dark, upon the grey vermiculated background of the older feathers. These dark feathers appear to be new. Tail as last described. Although grey vermiculated feathers predominate upon the abdomen, they are intermixed with a number of brownish feathers with black centres; some of the latter are new; others are due to pigment changes.

* On May 14th there were three curl feathers in the tail.

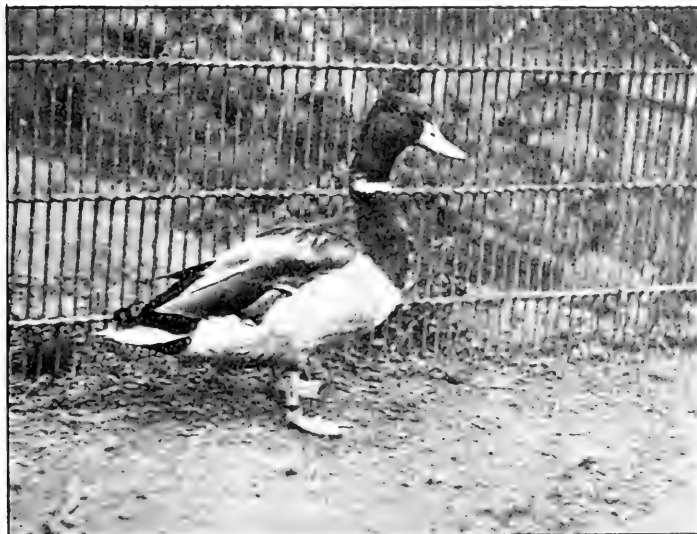
Text-figure 1.



The Mallard (No. 18) as it appeared on August 27th, 1907; castrated in December 1906.

The eclipse is far from complete, *i. e.* it has been delayed by the castration; the curl feathers have not as yet been lost, nor has the white ring on the neck fully disappeared, etc.

Text-figure 2.



Normal Mallard in full winter, or non-eclipse plumage.

August 11th, 1907.—Gloss on head limited; small irregular areas of it on sides of face and neck; white ring faintly represented at sides, absent in front and at back. The eclipse plumage is spreading rapidly upon the breast; this does not, however, present a typical appearance, although most of the feathers are brown with black centres, and the new ones coming through the down of the breast are of the eclipse type. There is no new flush upon the abdomen, though there are many brown feathers upon the flanks, where vermiculated feathers still prevail; it is not clear whether these brown feathers are new or not. In both wings the primaries, secondaries, and tertiaries are being rapidly moulted. Curly feathers are present in the tail.

August 18th, 1907.—No flight-feathers remain in either wing.

August 24th, 1907.—The eclipse on the body is not obviously proceeding. The curly feathers are still retained in the tail.

September 1st, 1907.—There is still a good deal of gloss on the vertex and the nape; the white ring is slightly indicated at the sides of the neck, not at the back or front. The breast is in almost full eclipse; the change is certainly largely due to the appearance of new feathers, but in part seems to be due to pigmentary change in the old. The feathers of the abdomen are, some eclipse, some vermiculated; there are feathers of both kinds, including a plentiful flush of young vermiculated feathers, on the flanks. There are no curl feathers in the tail, though these were present five days ago. The two central feathers are dark and glossy, and are beginning to ridge; the other tail-feathers are glossy, as they always have been.

September 12th, 1907.—The general aspect of the bird is intermediate; the majority of the breast-feathers that are fully grown are eclipse; there is, however, an abundant flush of young winter feathers coming through, although these do not yet affect the colour of the plumage. The vertex and the nape are glossy, but the cheeks present only a very few flecks of gloss; there is no trace of the white ring on the neck. Most of the feathers on the abdomen and posterior part of the breast are vermiculated; practically these are all old, but among them there is an abundant flush of young vermiculated feathers coming through: the eclipse feathers are few in number. On the flanks the feathers are almost entirely vermiculated, but many of them are tipped with brown, including a number of old (eclipse) feathers; new vermiculated feathers are coming through the down. The tail-coverts and back are glossy, with abundant new tail-coverts coming through. There are no curly feathers in the tail, but the central feathers are ridging and becoming glossy.

September 21st, 1907.—The general appearance is that of a bird in winter plumage, with the exception of the head and breast, for the majority of the breast-feathers are of eclipse type, in spite of a flush of winter feathers coming through and a considerable number of winter feathers which have already expanded.

The head has only a slight amount of gloss; the cheeks are only slightly flecked with the same. The feathers of the abdomen are predominantly vermiculated, a few eclipse feathers being left among them. The tail has one good curl feather and another ridging.

September 25th, 1907.—The head and neck are almost entirely glossy; the white ring is appearing, but the feathers of the breast are still largely of eclipse pattern, though many young feathers have come through. Among the vermiculated feathers of the abdomen a few eclipse ones are still present; practically all the young winter feathers have come through. The scapulars are unaltered. There are two curl feathers in the tail, and a third is ridging; the tail-coverts are glossy green, more so than when last described.

November 12th, 1907.—The bird is in full male winter plumage, with good curl feathers in tail. The only trace of the eclipse is to be found on the flanks, where there are still a few feathers tipped with brown and a few brown feathers which are not vermiculated at all. This bird was allowed to live until the end of July 1908, by which time, had it been a normal bird, it should have been in full eclipse, or even have been passing out of it.

The following note was made on July 27th, 1908:—The bird is in full eclipse, though there is a slight gloss upon the vertex. The breast is in eclipse, but there are a good many partially vermiculated feathers in the lower part of the breast and on the abdomen; there are no young feathers coming through. There are no curl feathers in the tail, but the two central are becoming glossy and beginning to ridge. The primaries and secondaries of the wing have been shed; the young feathers are not fully developed; the feathers of the flank are vermiculated, mixed with eclipse. The bird was killed and examined on July 30th, 1908. On the right side there was a series of loosely attached nodular grafts, which in total volume are about the size of a haricot; they were of a dull yellow, and brown on section. On the left side there were two small nodules, which, together, are the size of a small pea; there are other grafts, viz. at the root of the liver and attached to the mesentery; both these are of the size of small peas. All the testicular tissue is of a dull yellow colour.

(No. 13.) (Text-fig. 3, p. 35) Bird in full winter plumage; castrated December 20th, 1906. The testes removed were brown in colour, and did not exude fluid on section. Microscopically the tubules have a wide lumen and a many layered lining, with smaller cells about the centre. There are no spermatozoa, but mitotic figures occur in certain of the cells.

July 11th, 1907.—The general appearance of the bird is that of a male in almost full plumage. The vertex is dark green, though not definitely glossy; the cheeks are flecked with brown, but the white ring on the neck is perfect. There is a slight

lightening of the lower breast-feathers, and the feathers of the abdomen are generally somewhat browner and less grey than in the male in full plumage. There are four perfect curl feathers in the tail; the wing-feathers have not been shed, and are still quite firm.

September 11th, 1907.—Vertex dark, slightly glossy; only a few flecks of gloss on the cheeks; the white ring round the neck, just beginning to show after having disappeared. The breast is in eclipse; there is a moderate flush of young eclipse feathers coming through. The abdomen is in eclipse. The flank-feathers are almost entirely eclipse, but a few are in part vermiculated. There are no curl feathers in the tail (text-fig. 4).

January 24th, 1908.—Although the general appearance of this bird is predominantly that of a male in winter plumage, there are many signs that the eclipse is only slowly passing off. The vertex is dark, but it can scarcely be described as glossy, though the rest of the head is generally so, with only a few brown feathers remaining. The white ring, however, round the neck has now become well marked. There is much eclipse plumage left on the breast and abdomen. The flanks are in partial eclipse, a number of incompletely vermiculated feathers being present. The tail contains one poorly developed curl feather; the three other central feathers are dark and beginning to ridge—the first stage in the formation of the curl.

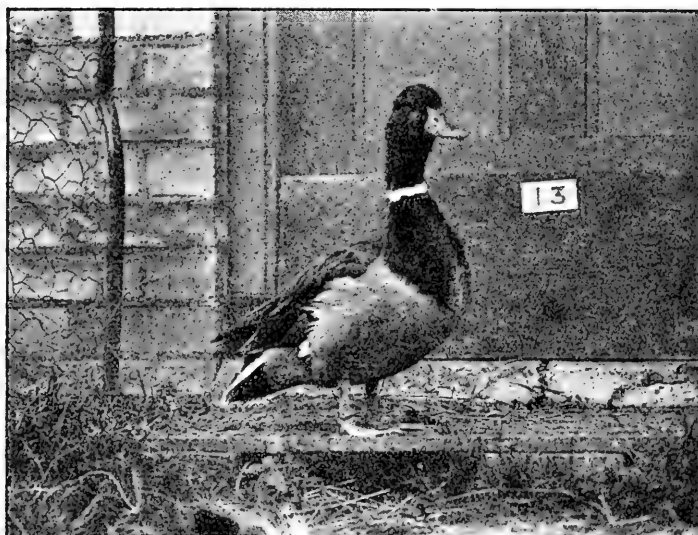
(No. 2.) Bird in full winter plumage; castrated December 20th, 1906. The testes removed were brownish yellow, and did not exude fluid on section. The tubuli were full of cells, and though no spermatozoa were present there were abundant mitoses.

July 11th, 1907.—Although the general appearance is that of a bird in winter plumage, it is modified by a considerable flecking with brown feathers on the sides of the face, and by the occurrence in the anterior portion of the grey of the breast, of individual feathers of a dull black edged with brown. The vertex is glossy, and there are four perfect curl feathers in the tail.

The photograph of this bird (text-fig. 5, p. 36), taken on September 11th, 1907, shows that the assumption of the winter plumage was delayed. The plumage is predominantly eclipse. There is no gloss on the head, and although the central tail-feathers are beginning to ridge, by far the greater number of the feathers on the head, belly, back, and shoulders exhibit wholly or in part the dusky coloration of the eclipse.

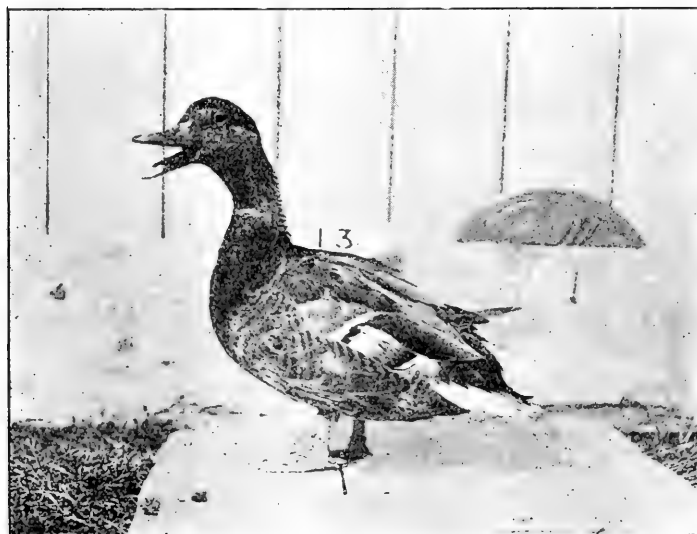
September 11th, 1907.—The vertex is dark and only slightly glossy; a few flecks of gloss are present upon the cheeks. There is no white ring on the neck. The feathers on the breast are predominantly eclipse, but here, and on the abdomen, there are feathers which are partially vermiculated, and there is an abundant flush of fresh vermiculated feathers coming through; among them there are a few eclipse feathers. The flanks contain many eclipse feathers and some new vermiculated ones. There

Text-figure 3.



Mallard (13), photographed in July 1907; in almost full winter plumage. The bird was castrated in December 1906. The eclipse has been delayed.

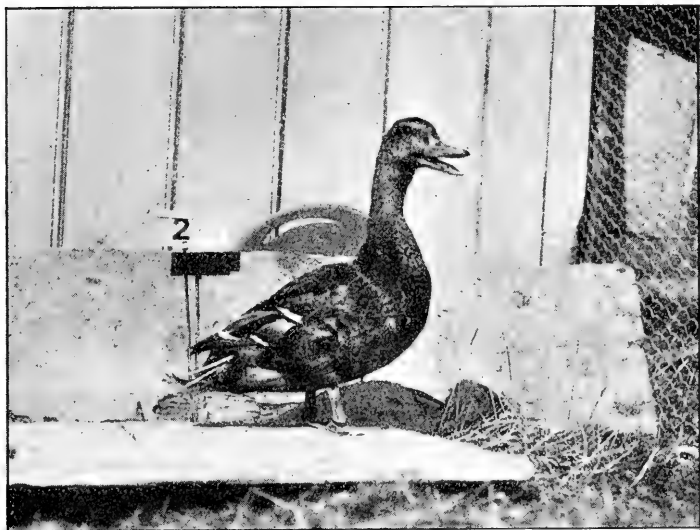
Text-figure 4.



The same Mallard as shown in text-fig. 3: photographed September 11th, 1907. The bird was castrated in December 1906. The advent of the eclipse in the summer of 1907 was delayed. The plumage is now largely of the eclipse kind; the bird was not fully out of eclipse in January 1908, before which time it should normally have been in complete winter dress.

is one glossy curl feather in the tail, probably new; two other feathers are beginning to ridge. Tail-coverts glossy.

Text-figure 5.



Mallard (2), photographed September 11th, 1907.

The bird was castrated in December 1906. The advent of the eclipse in the summer of 1907 was delayed. The photograph shows that the passage from the eclipse to the winter plumage is also delayed; the plumage is still predominantly eclipse; the vertex was only slightly glossy; the white ring has not reappeared on the neck; there was but one curl feather in the tail.

January 24th, 1908.—Bird completely male; four good curl feathers in the tail. On the flanks there is an occasional feather of a dusky brown colour with obscure vermiculations.

This bird was killed on February 19th, 1908, when a spheroidal graft, 6 mm. in diameter, was found in the abdomen. The tubuli of the graft were of full size, and active spermatogenesis was in progress.

(No. 48.) Bird in full winter plumage; castrated March 6th, 1907.

May 14th, 1907.—Bird in full plumage, with three curl feathers in the tail. The only premonition of the eclipse is a slight browning of some of the interscapular feathers and those upon the lower part of the breast.

July 11th, 1907.—The plumage has undergone but little

change, though the lustre has partly disappeared from the vertex, which is dark; and there is a little lightening of the lower chestnut feathers of the breast, which are tipped with white. There are three perfect curl feathers in the tail, and the old wing-feathers are quite firm and exhibit no tendency to be shed.

August 18th, 1907.—Much of the gloss on the vertex, and some of that on the cheeks, is retained; the breast is partly in winter, partly in eclipse plumage; the abdomen is in full winter plumage. There are some dark feathers on each flank.

September 11th, 1907.—The general aspect is that of a bird not quite in winter plumage; the head and neck are partially glossy, though there is still a good deal of brown upon the cheeks. There are some eclipse feathers in the breast, but the greater part are vermiculated and more winter feathers are coming through the down. The abdomen and the posterior part of the breast are completely vermiculated. There is one curl feather in the tail, and the tail-coverts are glossy. This bird was killed on September 12th, 1907. It presented a single graft the size of a small haricot: the tubuli were large and full of cells; in every tubule spermatogenesis was in active progress.

(No. 7.) Bird in full winter plumage; castrated April 5th, 1907. The testes were large and very soft, as when in full activity during this month.

On April 21st it was noted that there was a brownish wash-like tinting of feathers on the lower breast and abdomen.

July 27th, 1907.—Eclipse not complete. Some gloss on the vertex and cheeks; the white ring has disappeared. The chestnut area of the breast is only partially in eclipse. A number of eclipse feathers are coming through, though many look vermiculated. A large number of vermiculated feathers persist in the flanks, and there are many new vermiculated feathers in this position. Vermiculated feathers are coming through at the bases of the wings. The hinder part of the breast is greyish rather than vermiculated; no new feathers are coming through here. There are no curl feathers in the tail; the central feathers are ridging. The wing-feathers do not appear to have been as yet shed.

November 30th, 1907.—Bird in full male plumage; three curl feathers in the tail. The bird was killed and examined. There were a few encapsulated blood-clots about the site of operation, but no trace of the testes except two nodules situated close together and each the size of a millet seed. There were no nodules on the intestines or liver. Microscopic examination of the nodules referred to proved that they consisted of testicular tissue, some of the tubuli of which were distended with cells. No spermatozoa were present, and the central cells of the larger masses were degenerated.

(B.) The Results of Castration when performed on Birds
whilst in Eclipse Plumage.

(No. 11.) Bird in almost full eclipse plumage; castrated in July 1907. The head was in full eclipse, except that a few feathers on the side of the face showed a greenish gloss. The whole of the breast was in complete eclipse, with young eclipse feathers coming through in the anterior part. There were a few vermiculated feathers at the base of the neck behind. The primaries and secondaries had been shed from both wings, and there were no curl feathers in the tail, though a little gloss remained on the tail-coverts. The testes removed were about 22 mm. by 8 mm. in diameters, yellow in colour and firm on section.

September 17th, 1907.—The head has passed into almost complete winter plumage, although a few brown feathers are still present. The upper part of the chestnut area of the breast is in full winter plumage, though a considerable number of eclipse feathers are still present in the lower part of it. The grey portion of the breast and the abdomen are almost entirely vermiculated, though a few eclipse feathers are still present. Over the area plucked for operation in July the feathers are only faintly vermiculated and are of a greyish brown. There are two good curl feathers in the tail.

November 8th, 1907.—The bird was in full winter plumage, with four curl feathers in the tail. It was now killed. A graft the size of a small haricot was found at the site of the right testis.

(No. 12.) Bird in almost full eclipse; castrated July 1907. The testes were about 22 mm. by 8 mm. in diameters; pale yellow in colour and firm on section. The head is in almost complete eclipse, only the slightest glossiness persisting at the vertex. The chestnut area of the breast is in complete eclipse, with a few eclipse feathers still coming through the down; the rest of the breast is predominantly eclipse, although a few of the old vermiculated feathers persist. On the flanks there are both vermiculated and eclipse feathers. The wing-feathers have not been shed; there are no curl feathers in the tail. A good deal of gloss persists upon the upper tail-coverts and the feathers of the saddle.

September 17th, 1907.—The condition of this bird resembles that of the preceding (No. 11), with the following exceptions:—The head is not quite so advanced towards winter plumage, and the ring on the neck is not so well marked; there are fewer eclipse feathers in the lower part of the chestnut area; and there are three curl feathers in the tail.

November 8th, 1907.—Bird in full male plumage, with four curl feathers in the tail. It was now killed; at the site of the right testis there were three small grafts, one about the size of

a carraway seed, and two others about the size of a grain of maize and of a hemp seed respectively.

(No. 19.) Bird in full eclipse; castrated July 12th, 1906. The testes removed were of medium size, 15 mm. in longer diameter; the weight of each was about 3700 mg. The tubuli were fairly large, and distended with cells, without lumen. Here and there the spermatid sheaf arrangement was indicated. There were, however, no properly formed and stained spermatozoa.

September 11th, 1906.—Bird in almost full male plumage, except that the stippling on most of the vermiculated feathers has not attained its full darkness, and that the majority of these feathers are tipped with white.

January 24th, 1907.—Bird in full male plumage; there are two curl feathers in the tail.

April 4th, 1907.—Bird in full male plumage.

July 27th, 1907.—Bird in almost full eclipse, though there is a slight gloss on vertex. The grey upper portion of the breast is in eclipse, which must, however, be considered to be passing off, since there are many winter feathers coming through the down. The abdomen and the hinder part of the breast, eclipse. The wing-feathers have been moulted, but the new primaries and secondaries are not yet fully grown. There are no curl feathers in the tail.

The bird was killed on July 30th, 1907. On the left side there was a nodule the size of a small haricot, loosely connected with the great veins below the normal site of the testis. A group of grafts, together as large as a filbert, was loosely attached to the back of the liver.

(No. 13.) Bird in full eclipse; castrated July 8th, 1907. The testes removed were quite small, scarcely 10 mm. long by 5 mm. broad. The tubuli, of comparatively small size, were furnished with a well-differentiated lumen; cells two or three deep: no spermatozoa.

September 17th, 1907.—The bird still retains much of the eclipse plumage; there are some glossy feathers on the vertex and round the eye, but the rest of the head and neck are in definite eclipse, and the neck shows only the faintest remains of a white ring. The breast and the abdomen are in eclipse, though in both positions a few vermiculated feathers are coming through. The area which was plucked for the castration is slightly darker than elsewhere. On the flank many of the brown eclipse feathers are becoming vermiculated, and new vermiculated feathers are, in addition, appearing. There are no curl feathers in the tail; the moult of primaries and secondaries in the wings has been much delayed, as the new feathers have not yet attained their full size, and their shafts are still vascular.

November 18th, 1907.—The head is glossy, but many feathers on the cheeks are still partially brown; the white ring on the

neck is well developed. The chestnut area of the breast contains so many eclipse feathers that the general appearance of this part is eclipse, but there are also a few winter-plumage feathers intermixed. The lower part of the breast, though generally vermiculated, shows a small number of eclipse feathers. The area on the abdomen plucked in July for castration is covered with feathers, darker than elsewhere and only partially vermiculated; it might perhaps be described as "semi-eclipse" in character. A few eclipse and partially eclipse feathers persist in the flank. The tail contains two good curl feathers, and two others are ridging; all are glossy, as well as the tail-coverts. The bird was killed on this day. On the left side there was no trace of testicle, but on the right there was a nodule the size of a large haricot at the site of the gland, and below this a second, no larger than a millet seed.

Summary of the Effects of Castration upon the Plumage.

If we take the condition of No. 18 for the seven months succeeding the castration carried out early in December 1906, whilst the bird was in full male plumage, it appears that at the end of July 1907 (when the normal mallard has been in eclipse for some weeks) this bird still remained in almost full winter plumage. A careful water-colour drawing, made on July 23rd, 1907, by Mr. Norman H. Hardy, shows a bird in complete winter plumage, except for some small areas of brown on the cheeks and round the eyes, and a slightly diffuse tinting with brown of some of the vermiculated feathers on the abdomen. This bird, however, had passed through its eclipse, and had reassumed the full male plumage by September 21st. In July 1908, *i. e.* the following year, it passed into eclipse like a normal bird. The record of No. 13, castrated during the latter half of September, when the bird was in full male plumage, shows a similar result; but in this case the delay in the appearance of eclipse feathers was even more marked than in No. 18; while in both the birds not only was the eclipse delayed, but it was incomplete.

The behaviour of No. 48, castrated in March 1907, resembled that of No. 18, though the delay in the onset of the eclipse was not so marked; in No. 7, the testes of which were removed in April 1907, there was comparatively little delay.

Whilst there can be no doubt that the removal of the testes during the period of the eclipse does not retard the assumption of the proper male or winter plumage; castration carried out, on the contrary, whilst the bird is in full male plumage delays the appearance of the eclipse. This delay is not so much a positive delay as an abnormal persistence of the winter plumage. For if the winter feathers be plucked (*i. e.* artificially shed), the new feathers that replace them are of the typical eclipse kind.

Text-fig. 6 shows a bird concerning which it is no exaggeration

to say that half the area on the breast and abdomen, which is normally vermiculated, exhibits the eclipse plumage, while the rest is in male or winter plumage. This bird (No. 75) was castrated in May. In the middle of July its general appearance, whilst standing, was quite male, for the only obvious sign of the oncoming of the eclipse was a slight loss of the gloss on the vertex of the head and a browning of the cheeks; the curl feathers in the tail were still unshed—*i. e.*, the appearance of the eclipse was delayed, as usual, after castration. But on lifting up the bird, it was seen that the abdomen and breast, where they had been plucked for castration in May, were covered with a thick growth of buff and black eclipse feathers. Although this is the most marked example of the growth of eclipse feathers in plucked areas of castrated birds otherwise in winter plumage, we have seen the same thing in a less degree in other cases.

Text-figure 6.



A Mallard (75) castrated in May.

The abdomen and lowest part of the breast (plucked under ether anaesthesia for castration) have become (middle of July) covered with a growth of buff and black eclipse feathers, the plumage being otherwise of the winter kind, *i. e.* the appearance of the eclipse elsewhere has been delayed.

The ducks distinguished as Nos. 18, 48, and 69 were killed during late summer or early autumn, *i. e.* at a time when the testes are normally in an inactive condition. We unfortunately omitted to examine the histological condition of the "grafts" in No. 18, killed July 30th, 1908; but in the case of No. 48, killed

on September 12th, 1907, spermatogenesis was in full progress in the graft, a condition of activity which does not occur under normal conditions at this period of the year.

In the case of two additional castrated birds (not further recorded in this paper) which were killed between the end of June and September 1907, spermatogenesis was likewise taking place in similar grafts: *i. e.*, at a time when in normal birds the testes are functionless, at least as regards their external secretion. The histological condition found in the grafts in these different birds is shown in the following table:—

(No. 8 *m.*) Killed: June 1907 (late).

Condition of grafts:

One graft about the size of a small gooseberry; the tubuli are of large size and distended with cells; mitotic figures fairly abundant. In the centre of one tubule is a group of deeply-stained filaments with bulbous ends, which must be considered spermatozoa.

(No. 39.) Killed: September 12th, 1907.

Condition of grafts:

One graft about the size of a large pea. This consists of the epididymis and testicular tissue, the tubuli of which are of full size; spermatogenesis is in active progress.

(No. 48.) Killed: September 12th, 1907.

Condition of grafts:

One graft the size of a small haricot. The tubuli are large and distended with cells; in every tubule spermatogenesis is in full progress.

(No. 22 bis.) Killed: Mid-September 1907.

Condition of grafts:

Graft consists of closely-set tubuli of large size and full of cells. Spermatogenesis with well-developed spermatozoa present in some of the tubes: in other tubuli the centre is filled with a vacuolated mass of cell-débris without spermatozoa.

Conclusions.

I. In the male of the Wild Duck the testes undergo annually a series of seasonal changes (as in many other birds), and are spermatogenic only during the winter months and early spring.

II. The periods of activity and non-activity do not coincide with the two seasonal changes in the plumage.

III. The normal passage of the bird from full winter (breeding) plumage to its dusky summer (eclipse) plumage is, however, delayed if castration is carried out during the months whilst the gland is assuming, or has attained, its activity.

One bird (No. 18) which was castrated in the winter, and in which the advent of the succeeding eclipse was delayed the following summer, was kept until the summer of the next year.

In this case the second eclipse occurred at the normal period.

As, however, small nodules of regenerated testicular tissue were found at the autopsy (as indeed they were in every other case), we are not at present in a position to say whether a Mallard which is absolutely without testicular tissue will continue to pass through the same seasonal changes of plumage as the normal bird.

It is a remarkable fact that the grafts were fully spermatogenic in the month of September, an occurrence altogether abnormal in the testicle of the entire bird. We can offer no explanation of this anomaly.

The delay above referred to has its parallel in the well-established fact that if a colt is castrated when shedding its winter coat, the shedding is for a time arrested, and then proceeds only very slowly.

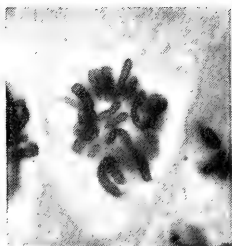
It is of interest to observe here that in the case of the Wild Duck, when females assume the male plumage (a phenomenon well known also in the Common Pheasant and other birds), the spurious males undergo the seasonal eclipse, although this is somewhat incomplete and aberrant.

IV. Removal of the testes during the eclipse does not produce any constant, appreciable effect upon the next passage of the bird into winter plumage.

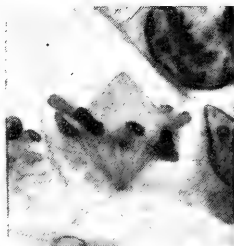
It would appear from these observations that the seasonal change of plumage in the Mallard is not connected with the spermatogenic function of the testicle.

But whether a second function of the organ, viz. the production of an internal secretion, or hormone, is responsible for the change, could only be proved by castration so effectively carried out as to exclude absolutely any reproduction of testicular tissue.

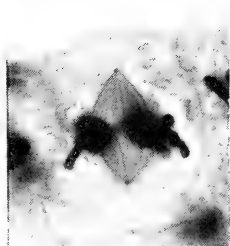
The only method of ensuring this is to reopen the abdomen after the castration, and remove any nodules of reproduced tissue. Our results in this direction we may lay before the Society on some future occasion.



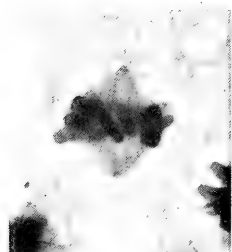
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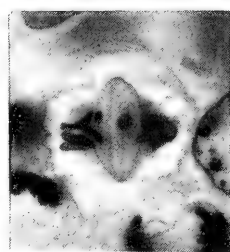
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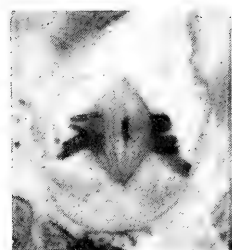
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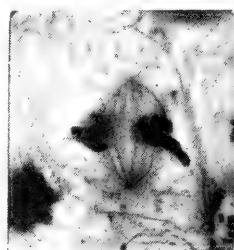
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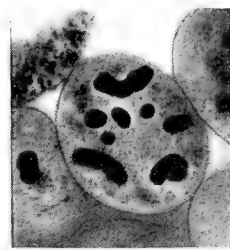
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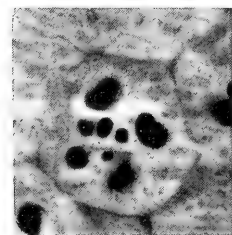
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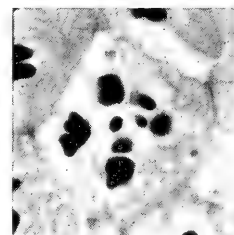
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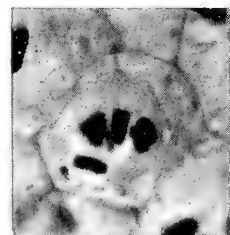
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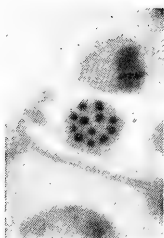
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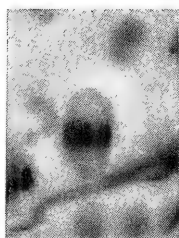
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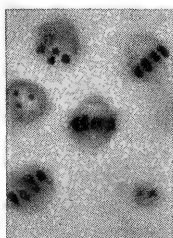
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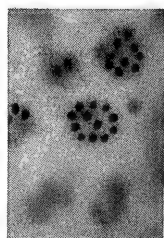
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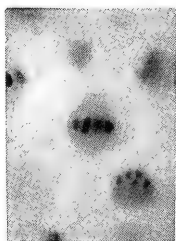
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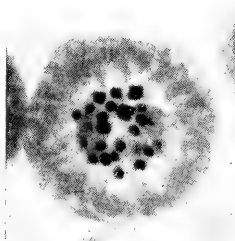
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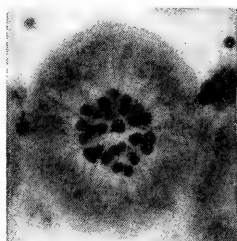
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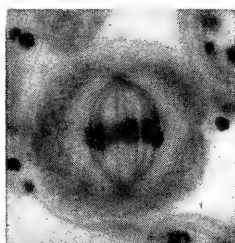
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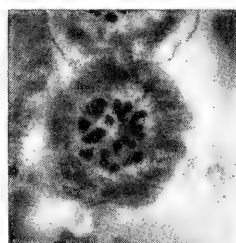
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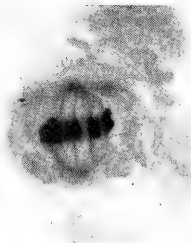
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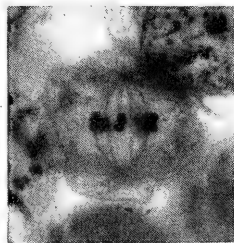
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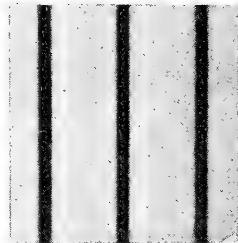
22.



23.



24.



25.

3. The Possible Connection between Spindle-Length and Cell-Volume. By C. F. U. MEEK, M.Sc., F.L.S., F.Z.S.

[Received October 31, 1913 : Read February 17, 1914.]

(Plates I. & II.*)

INDEX.

Cytology.

Introduction.

I have stated that in *Forficula auricularia* and *Helix pomatia* the ratio between the lengths of the mitotic spindle at the conclusion of the two spermatocyte metaphases is identical, or almost identical, with the ratio between the radii of two spheres of which the volume of one is equal to twice that of the other; and the same ratio has been observed by von Winiwarter in the spermatocyte metaphases of Man. Since each primary spermatocyte divides to form two daughter secondary spermatocytes, and since no period of growth seems to separate their mitoses, the volume of the primary spermatocyte cell in the metaphase is presumably equal to twice that of the secondary spermatocyte. Connection is therefore suggested between the spindle-length and cell-volume at this stage.

Although this ratio has been observed in organisms representing three phyla of the animal kingdom, the inference is speculative; for coincidence may be responsible for the apparent connection. I pointed out in an earlier paper that only one generalisation seemed to have been established concerning the mitotic spindle, namely, that it is not a figure formed entirely by the action of forces at its poles. We have since found that its length at the conclusion of spermatogenetic metaphases cannot be correlated with the volume of the chromatin; and, if we can eventually prove that the length at this stage is or is not connected with the volume of the cell, we shall have succeeded in establishing another generalisation.

In a paper on chromosome dimensions, published in 1912, I stated that increasing somatic complexity of the organism seemed to be accompanied by increase of chromatin volume in the germ-cell. The measurements given, however, proved that no theory depending entirely upon a quantitative analysis can suffice; for, in certain cases, the difference of chromatin volume in widely separated organisms was found to be less than that in organisms belonging to sister families.

I now intend to compare the volumes of spermatocyte cells in *Helix pomatia*, *Forficula auricularia*, *Triton cristatus*, and Man—organisms representing three phyla; and, in order that a comparison may be possible also in organisms belonging to allied

* For explanation of the Plates see p. 49.

families, I have included in Pl. I. photo-micrographs of spermatocyte cells of two species of *Stenobothrus*, of which the family is sister to that of *Forficula*. We know that the length of the spindle in spermatocyte metaphases cannot be correlated with the degree of somatic complexity of the organism; and, from the investigations now to be carried out, we shall know if the volumes of these cells cannot be so correlated. Moreover, the photo-micrographs of cells in *Forficula auricularia* and *Helix pomatia* will afford opportunity of verifying my original measurements of spindle-lengths at the conclusion of the metaphase.

Material and Methods.

All material was fixed in Flemming's strong chromo-aceto-osmic acid fluid, in which it remained for twelve hours. It was then washed for twenty-four hours in running water; and, after being passed through successive strengths of alcohol, was embedded in paraffin. Sections were cut 8 or 10 μ thick with a Cambridge rocking microtome.

The slides were stained for either twelve hours in Heidenhain's iron hæmatoxylin, or fifteen hours in iron brazilin. In the former case the mordant was an aqueous solution of ferric alum, and the slides remained in it for four hours; in the latter case they were put for two hours into a solution of ferric alum in 70 per cent. alcohol. The iron brazilin enables spindle fibres to be seen distinctly, and is a useful stain when camera-lucida drawings or photo-micrographs are required.

The preparations were studied with a Zeiss apochromatic oil-immersion objective of 3 mm. focus and N.A. 1.40, and the various compensating oculars. The light was obtained from a Graetzin lamp, and was passed through the holoscopic oil-immersion substage condenser made by Messrs. Watson & Sons of London. With one exception, all photo-micrographs shown were made at the same magnification with a Zeiss camera, the apochromatic objective mentioned above, and compensating ocular No. 4. The camera extension was 50 cm. The magnification was estimated with a stage micrometer graduated to read one hundredth part of a millimetre, and a photo-micrograph of this scale is included in Pl. II. The negatives and prints have not been retouched.

A Comparison of the Volumes of Spermatocyte Cells in different organisms.

Figs. 1-24 of the Plates are polar and lateral views of cells in the metaphase or earliest anaphase.

Figs. 1-8 inclusive represent spermatocyte cells in *Triton cristatus*. Fig. 9 represents a primary spermatocyte cell in *Stenobothrus viridulus*, and cells of this generation in *S. curtispennis* are shown in figs. 10, 11, & 12; in fig. 12, which is a lateral view, the odd or heterotropic chromosome is seen passing

undivided to one pole. The primary and secondary spermatocyte cells of *Forficula auricularia* are respectively represented by figs. 13, 14 and 15, 16, 17. Figs. 18 to 21 show the primary spermatocytes of *Helix pomatia*, and the secondary spermatocytes are shown in figs. 22 to 24.

Now, exact measurements of cell-volumes cannot be made; but it is evident from the photographs that, in the metaphase, the primary spermatocyte cells of *Triton cristatus*, *Stenobothrus viridulus*, *S. curtipennis*, and *Helix pomatia* differ from one another only slightly in size, and are considerably larger than those in *Forficula auricularia*. Moreover, drawings sent to me by Dr. von Winiwarter show that in Man these cells are smaller than those of *Triton*, *Stenobothrus*, and *Helix*. And the same results are obtained if we compare the secondary spermatocyte cells.

In the circumstances, we must realise that cells of these two generations may be of similar sizes in widely separated organisms, and of very different sizes in organisms that are closely allied; and increasing somatic complexity of the organism is not necessarily accompanied by increase of the volumes of these cells.

The Length of the Mitotic Spindle at the Conclusion of the Spermatocyte Metaphases of Helix pomatia (Pl. II. figs. 18-24) and Forficula auricularia (Pl. II. figs. 13-17).

We will deal first with spindle-lengths in *Helix pomatia*. Figs. 18 & 19 are polar views of the equatorial plate in the primary spermatocyte metaphase. Figs. 20 & 21 are lateral views, showing constriction of the chromosomes in progress. I estimated the spindle-length at the conclusion of this metaphase to be 15.3μ ; and, since the length found from these two photographs for the slightly earlier stage is 15μ , my original measurement seems to have been accurate.

Fig. 22 is a polar view of the equatorial plate in the secondary spermatocyte metaphase. Fig. 23 is a lateral view of the spindle at the conclusion of this metaphase. The spindle-length at this stage was said to be 12.1μ , and this measurement is now verified; for I am not attempting in this paper to express spindle-lengths in terms smaller than half a micro-millimetre, and the length found from the photograph is 12μ . Fig. 24 shows a slightly later stage, when the anaphase has begun; the length of the spindle in this cell is found to be 12.5μ .

Let us now consider the spindles of *Forficula auricularia*. Fig. 16 is a polar view of the secondary spermatocyte complex; ten chromosomes are arranged on the periphery of the spindle, and two lie within it. Figs. 15 & 17 are lateral views of this mitosis; the chromosomes are constricting in the equatorial plane, and the stage depicted therefore immediately precedes the conclusion of the metaphase. The length of the spindle,

estimated from the magnification, is $8\ \mu$ in each cell, and this confirms my original measurement; for the length was said to be $7.8\ \mu$ during constriction and $8.1\ \mu$ at the moment when constriction was complete.

Fig. 13 is a polar view of the primary spermatocyte complex, and all the chromosomes are shown. Fig. 14 is a lateral view at the conclusion of the metaphase; the chromosomes have completed constriction, and the daughter rods are ready to move towards the two poles. This photograph has been made at a magnification greater by $\frac{1}{3.5}$ th than that of the remaining figures. In my earlier paper the length at this stage was said to be $10.4\ \mu$; and, since the length, estimated from the photograph, is $10.5\ \mu$, my original measurement is seen to have been accurate.

There is, however, a new factor that must be considered in the case of this organism. I remarked in my paper that, at the conclusion of the primary spermatocyte metaphase, certain cells showed a spindle-length greater than that required by the ratio. Such spindles seemed to be distorted, and, after careful consideration, I assumed that they were abnormal in that their true form had been destroyed in the process of section-cutting. I have recently studied new preparations of this material, and have again found spindles of excessive lengths. These occur in cells that are closely packed together; but, since many of the spindles show no sign of distortion, we are not justified in assuming abnormality in every case.

Four explanations can be put forward. First, the volume of these cells in the metaphase may vary, and our proposition may still be valid. In this case, however, various lengths will presumably be found at the conclusion of the secondary spermatocyte metaphase; and I have not observed such lengths. Secondly, the daughter chromosomes may remain apposed to one another in the equatorial plane for a considerable time after constriction is complete: if centrosome divergence continues during this period, the various and excessive lengths may be explained. This, however, cannot always occur; for, in this organism, I have found and drawn primary spermatocyte cells in which the daughter chromosomes have begun to move towards the poles when the spindle-length is only slightly greater than that estimated for the conclusion of the metaphase. Thirdly, our proposition may require modification in that the length of the spindle may be affected by the shape of the cell. My original measurements in *Forficula* and *Helix* were made from cells that were approximately spherical, and this may explain the constant lengths observed. When, however, cells are closely packed together in a cyst, the spherical form disappears, and, if our modification is valid, the spindle-length will vary with the shape assumed. Lastly, the length of the spindle at this stage may be connected with neither the volume nor shape of the cell; and, in this case, our proposition is entirely disproved. If, however,

this is so, why has the ratio in question been observed in *Helix pomatia* and Man?

I hope to deal with these explanations in a subsequent paper. In the meantime, the proposition remains a suggestion.

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- „ The Length of the Mitotic Spindle in the Spermatocyte Metaphases of *Helix pomatia*. Proc. Roy. Soc., ser. B, vol. lxxxvii. No. 594.

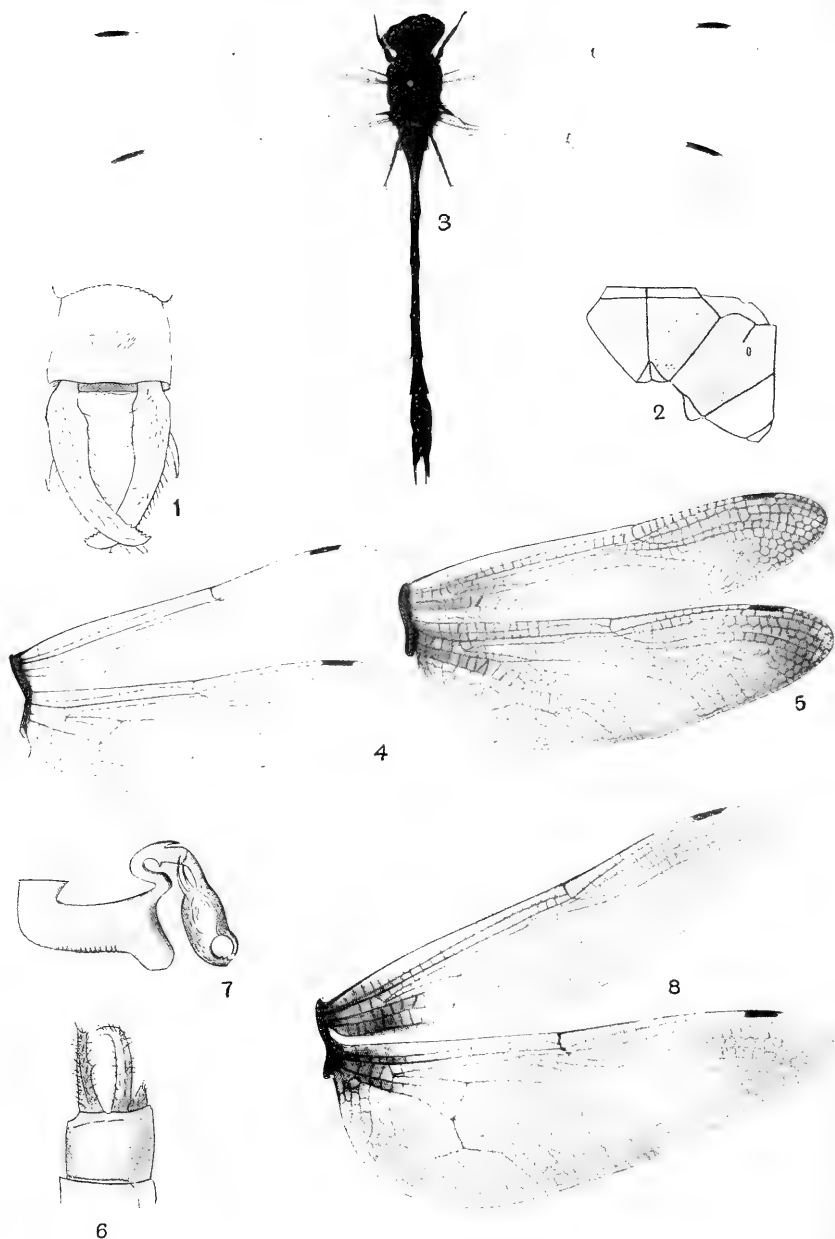
EXPLANATION OF THE PLATES.

PLATE I.

- Figs. 1-8. Polar and lateral views of spermatocyte cells of *Triton cristatus*, in the metaphase and earliest anaphase.
9. Polar view of equatorial plate in primary spermatocyte metaphase of *Stenobothrus viridulus*.
 - 10, 11. Polar views of equatorial plate in primary spermatocyte metaphase of *Stenobothrus curtipennis*.
 12. Lateral view of spindle in primary spermatocyte metaphase of *Stenobothrus curtipennis*; the odd or heterotropic chromosome is seen passing undivided toward the lower pole of the figure.

PLATE II.

- Fig. 13. Polar view of equatorial plate in primary spermatocyte metaphase of *Forficula auricularia*.
14. Lateral view of spindle at conclusion of primary spermatocyte metaphase of *Forficula auricularia*.
 16. Polar view of equatorial plate in secondary spermatocyte metaphase of *Forficula auricularia*.
 - 15, 17. Lateral views of spindle in secondary spermatocyte metaphase of *Forficula auricularia*.
 - 18, 19. Polar views of equatorial plate in primary spermatocyte metaphase of *Helix pomatia*.
 - 20, 21. Lateral views of spindle in primary spermatocyte metaphase of *Helix pomatia*.
 22. Polar view of equatorial plate in secondary spermatocyte metaphase of *Helix pomatia*.
 23. Lateral view of spindle at conclusion of secondary spermatocyte metaphase of *Helix pomatia*.
 24. Lateral view of spindle in earliest secondary spermatocyte anaphase of *Helix pomatia*.
 25. Divisions of stage micrometer, 10 μ apart, showing magnification of figs. 1-13 and 15-24.



University Press Cambridge.

4. Contributions to a Study of the Dragonfly Fauna of Borneo.—Part II. The Gomphinae and Chlorogomphinae.
By F. F. LAIDLAW, M.A., F.Z.S.

[Received October 18, 1913 : Read February 17, 1914.]

(Plate I. *)

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Introductory remarks.—I have dealt at some length with the venation of the various species discussed below, more especially with the species belonging to the Chlorogomphinae; chiefly because all of them, and especially the latter, are very rare in collections, and because they are of particular systematic interest to the student of the Odonata.

With regard to the distribution of these members of the Dragonfly fauna, too little is known to admit of dogmatic statements or even of useful discussion. The genera which seem to be essentially characteristic of the Great Sunda Islands are *Macrogomphus* and *Microgomphus*, the latter unknown beyond their limits; all the other genera here recorded have a wide distribution in the Orient, and in the case of *Ictinus* beyond it. At the same time the Gomphine fauna of Tropical Asia is as sharply characterized as that of any other quarter of the earth.

ICTINUS ACUTUS, sp. n. (Selys nom.) (Pl. I. fig. 1.)

2 ♂♂. Baram, Oct. 1910.

Length of abdomen 45 mm. + 3 mm.; hind wing 36 mm.; pterostigma 5 mm.

Venation:—

An.n. $\frac{19 \text{ or } 20}{14 \text{ or } 15}$; Pn.n. $\frac{13 \text{ or } 14}{15}$; t. $\frac{3-4\text{-celled}}{3\text{-celled}}$; ti. $\frac{3 \text{ celled}}{1.2.2.3\text{-celled}}$; supr.t. $\frac{2}{2}$.

Belongs to the group *I. decoratus* de Selys.

Wings tinged with brown; orange at the base—in the fore wing for about one-third the length of the median space, but excluding the cubital space; in the hind wing almost up to the arculus. Pterostigma brown.

Head: Upper lip yellow, edged with black, the black reaching

* For explanation of the Plate see p. 63.

the base of the lip in the middle line; rhinarium yellow, marked below with a transverse black line. Nasus and frons brownish black; the former has a small round yellow spot on either side, the latter carries a pair of transverse yellow spots at its summit, these are separated narrowly in the middle line by black. Vertex and occiput entirely brownish black.

Prothorax very dark brown, its under surface and base of the prothoracic limbs paler.

Thorax rich chestnut-brown, marked with yellow as follows:—A mesothoracic half-collar divided by the black median dorsal carina; a dorsal stripe on either side, incomplete below, and an antehumeral stripe constricted at its middle; a narrow band on the mesepimeron and a second band, likewise narrow, on the metepisternum. Nearly the whole metepimeron is yellow, its posterior border narrowly marked with black, whilst the metasternum is entirely black.

Legs: Femora dark brown, the first pair with a narrow internal stripe; tibiae and tarsi black.

Abdomen largely black, segments 1, 2 brown below and at the sides, auricles brown, 2 with a yellow dorsal band narrowing to a point at the apex of the segment; 3, 4, 5, 6 black, each with a small basal yellow mark dorsally, which is triangular in shape with its apex directed backwards (in the more adult of the two specimens these markings are of a brown colour rather than yellow). Anterior third of 7 yellow dorsally, 8, 9, 10 largely brown at the sides; the distal half of 10 is also brown dorsally; laminae of 8 black.

Anal appendages black; upper pair fully equal in length to 9, 10 together, curved inwards a little and crossing each other like the blades of scissors. Each bears a strong sharp spine on its outer margin, rising at the junction of the inner and middle third of its length, and the inner margin of each is finely serrated near its apex. Lower appendage very short, almost concealed by the anal tubercle, abruptly truncate, with a small hooked spur on either side.

This fine form is well characterized by the anal appendages, which are unlike those of any of the described species. The type-specimen has been examined by M. René Martin, who has very kindly informed me that it is identical with an example in the de Selys collection labelled *I. acutus*, which has not been described.

(The type is in the British Museum; co-type, Sarawak Museum.)

**ICTINUS DECORATUS* de Selys.

Ictinus decoratus Selys, Hagen, Monogr. Gomph. p. 273, pl. 14. fig. 4; Kirby, Cat. Odonata, p. 77; Krüger, Stettin. Entom. Zeitg.

* Species marked with an asterisk are those of which I have not received examples from Mr. Moulton.

1898, p. 315; Williamson, "Gomph. etc. of Burma," Proc. U.S. Nat. Mus. xxxiii. 1907, p. 279; Martin, Mission Pavie, p. 14 (sep.) (1904).

Recorded from Borneo (*Martin*), Sumatra (*Krüger*), Java (*Selys*), and Tonkin (*Martin*).

ICTINUS MELENOPS de Selys.

Ictinus melenops Selys, Hagen, Monogr. Gomph., pp. 532, 686, pl. 15. fig. 1; Selys, Addit. Synops. Gomph., Bull. Acad. Roy. Belg. 2. vii. 1859, p. 548; Karsch, Entom. Nachr. xvii. 1891, p. 244; Kirby, Cat. p. 77; Martin, Mission Pavie, p. 14 (sep.) (1904); Williamson, loc. cit. p. 280, figs. 7, 8, 29; Ris, Ann. Soc. Entom. Belg. lv. 1911, p. 239.

Ictinus melenops, race *sumatranus*, Krüger, Stettin. Entom. Zeitg. 1898, p. 315.

I have examined one female taken at Kuching in December 1899 (Sarawak Museum Collection).

The species is recorded also from Sumatra (*Karsch*, *Krüger*) and Malacca (*Martin*), Cambodia and Tonkin (*Martin*).

*GOMPHIDIA MACLACHLANI de Selys.

Gomphidia maclachlani de Selys, 2^{me} Addit. Synops. Gomph., Bull. Acad. Roy. Belg. 2. xxviii. 1869, p. 767; Kirby, Cat. p. 76; Krüger, Stettin. Entom. Zeitg. 1898, p. 314; Martin, Mission Pavie, p. 14 (sep.); Williamson, loc. cit. pp. 281-282.

Recorded from Borneo (*Selys*), Sumatra (*Krüger*), Tonkin and Anam (*Martin*).

*GOMPHIDIA KIRSCHI de Selys.

Gomphidia kirschi Selys, 4^{me} Addit. Synops. Gomph., Bull. Acad. Roy. Belg. 2. xlv. 1878, p. 673; id., Anal. Soc. Españ. de Hist. Nat. xi. 1882, p. 18; Kirby, Cat. p. 76; Martin, Mission Pavie, p. 14 (sep.); Williamson, loc. cit. p. 283.

Recorded from the Philippine Is. (*Selys*), Borneo (*Selys*), and Tonkin (*Martin*).

SIEBOLDIUS JAPONICUS de Selys.

Sieboldius japonicus Selys, Hagen, Monogr. Gomph. p. 224, pl. 13. fig. 3; Kirby, Cat. p. 76; Williamson, loc. cit. p. 285, fig. 11.

Sieboldius grandis Krüger, Stettin. Entom. Zeitg. 1898, pp. 311-314; Laidlaw, Proc. Zool. Soc. Lond. 1902, i. p. 81, pl. vi. fig. 33 a.

I have examined a male of this fine species, collected by Mr. Moulton. It agreed closely with the male taken by myself in Perak. Williamson is probably correct in regarding Krüger's species as not distinct from that of de Selys.

Ranges from Japan to Borneo. ⁴

*MACROGOMPHUS ALBARDÆ de Selys.

Macrogomphus albardæ Selys, 4^{me} Addit. Synops. Gomph., loc. cit. pp. 416-418; id., Ann. Mus. Civ. Genova, xxvii. 1889, p. 469; Kirby, Cat. p. 63; Karsch, Entom. Nachr. xvii. 1891, p. 224; Krüger, Stettin. Entom. Zeitg. 1898, p. 300; Williamson, loc. cit. p. 289; Ris, Ann. Soc. Entom. Belg. lv. 1911, p. 238, figs. 7, 8.

Recorded from Sumatra (*Selys*) and Borneo (*Ris*).

MACROGOMPHUS DECEMLINEATUS de Selys.

Macrogomphus decemlineatus Selys, 4^{me} Addit. Synops. Gomph. pp. 418-419; id., Ann. Mus. Civ. Genova, xxvii. 1889, p. 469; Kirby, Cat. p. 63; Krüger, Stettin. Entom. Zeitg. 1898, p. 203; Williamson, loc. cit. p. 289.

2 ♂ from Kuching, May 1896 (Sarawak Museum Collection).

Recorded from Sumatra (*Selys*) and Borneo (*Selys*).

*MACROGOMPHUS QUADRATUS de Selys.

Macrogomphus quadratus Selys, 4^{me} Addit. Synops. Gomph. p. 415; id., Ann. Soc. Entom. Belg. xxvii. 1884, p. x; id., Ann. Mus. Civ. Genova, xxvii. 1889, p. 469; MacLachlan, Ann. Soc. Entom. Belg. xxviii. 1884, p. vii; Förster, Ann. Soc. Entom. Belg. xliii. 1889, p. 65; Kirby, Cat. p. 63; Krüger, Stettin. Entom. Zeitg. 1898, pp. 296-297; Williamson, loc. cit. p. 287.

From Borneo (*Selys*) and Sumatra (*Selys*).

MICROGOMPHUS CHELIFER de Selys.

Microgomphus chelifer Selys, Hagen, Monogr. Gomph. p. 364; Selys, Addit. Synops. Gomph. p. 533; Kirby, Cat. p. 63; Krüger, Stettin. Entom. Zeitg. 1898, p. 302; Laidlaw, Proc. Zool. Soc. Lond. 1902, i. p. 79; Williamson, loc. cit. pp. 295-296, figs. 21, 22.

1 ♂. Saribas, 1910.

A new record for Borneo. Known from Malacca (*Selys*) and Sumatra (*Krüger*).

*LEPTOGOMPHUS SEMPERI de Selys.

Leptogomphus semperi Selys, 4^{me} Addit. Synops. Gomph. pp. 443-444; Martin, Mission Pavie, p. 11 (sep.); Kirby, Cat. p. 70; Williamson, loc. cit. pp. 292-293, fig. 17; Ris, Suppl. Entom. Deutsch., Entom. Mus. no. 1, 1912, p. 69.

Recorded from Borneo (*Martin*), Philippines (*Selys*), Tonkin (*Martin*).

LEPTOGOMPHUS WILLIAMSONI Laidlaw.

Leptogomphus williamsoni Laidlaw, Journ. Str. Br. R. Asiat. Soc. [no. 63] Dec. 1912, p. 94, figs. 1, 2.

This species belongs to section B of the genus as defined by Ris.

It has the basal subcostal nerve of the second series present on all four wings; the hamuli are large and the "Penischale" is small. The upper pair of anal appendages are very similar to those figured by Ris for *L. perforatus* Ris and *L. sauteri* Ris.

It is characterized by the possession of a single row of cells only in the whole anal area, and by the rather striking yellow spot on the dorsum of segment 10 of the abdomen. (For figures of genital appendage of this species see Laidlaw, *loc. cit.*)

The type ♂ is in the British Museum.

[*LEPTOGOMPHUS KELANTANENSIS* (Laidlaw).*†

Leptogomphus kelantanensis Williamson, *loc. cit.* p. 291 (1907).

Gomphus consobrinus Laidlaw (nom. preoccup.), *Proc. Zool. Soc. Lond.* 1902, i. p. 80, pl. v. fig. 5.

Gomphus kelantanensis Laidlaw, *Proc. Zool. Soc. Lond.* 1902, ii. p. 382 (footnote).

This species belongs to section A of the genus, according to Dr. Ris' arrangement. There is no basal postcostal of the second series, the hamuli are small, and the "Penischale" large. The single male captured is fully adult and its sober colouring is excellently shown in Mr. Wilson's figure, where the venational characters are also satisfactorily exhibited (*Proc. Zool. Soc. Lond.* 1902, pl. v. fig. 5).

Like *L. williamsoni*, this species has its anal area composed of a single row of cells. The upper anal appendages are rather small, with a single well-marked but small tooth on their outer side at about the middle of their length; the appendage terminates in a fine upturned point; each extremity of the lower appendage is hooked upwards rather abruptly at its termination.

The type ♂ is in the Zoological Museum of the University of Cambridge.]

BURMAGOMPHUS VERMICULATUS (Martin), subsp. *INSULARIS*, nov. (Pl. I. fig. 2.)

Gomphus vermiculatus Martin, *Mission Pavie*, p. 11 (sep.).

Burmagomphus vermiculatus Williamson (nec Martin?), *loc. cit.* pp. 298-301, figs. 27, 28, 29 (10); (Ris, *Tijdschrift v. Entom.*, Deel lv. 1912, p. 164).

1 ♂.

An interesting addition to the fauna of Borneo. In size it agrees closely with Williamson's specimens from Burmah, in most other respects it appears to approach the individuals described by Martin from Tonkin. I am disposed to believe that Williamson's examples represent a species distinct from the true *B. vermiculatus* of Martin; but cannot be certain on the point without a good supply of material from the two localities.

In any case the present specimen agrees rather with Martin's specimen than with those described by Williamson.

* Not recorded from Borneo.

† [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature. (*Proc. 7th Int. Cong. Boston, 1907*, p. 44 (1912).—EDITOR.)]

The individual here recorded shows well the generic characters tabulated by Williamson. The wing characters are almost identical with those shown in his figure (*loc. cit.* fig. 27). A difference which may be merely individual, but if not, one that I should regard as of specific importance, is that the anal triangle of both hind wings of the Bornean specimen is divided into two cells only, by a cross-nerve running parallel to the long axis of the wing. Williamson's figure might well have been taken from this representative specimen from Borneo excepting for this, for the difference in the number of antenodal and postnodal nerves, and for the fact that in the Burmese specimen figured the area included between Cu_2 and A_1 in the hind wing is a little shorter and broader than in the individual under consideration; and, lastly, for a slight difference evident in the relative size of the pterostigmata.

Details are as follows:—

Length of abdomen 28 mm.

Length of hind wing 28 mm.

Venation:—

$$\begin{array}{rcc} & 13-12 & 9-9 \\ \text{An.n.} & \frac{\quad}{9-8} & ; \text{Pn.n.} \frac{\quad}{8-10} \end{array}$$

Pterostigma a shade longer and narrower than in the type of the genus, covering 4 cells in the front wing.

Head: Anterior surfaces black, with a rectangular yellow mark on either side of the upper lip, and a yellow spot at each angle of the lip; a transverse yellow band along the crest of the frons divided by a fine median line into two lateral halves.

Thorax black above, marked with a yellow mesothoracic half-collar interrupted in the middle line, tapering laterally. A pair of narrow dorsal stripes of the same colour, not reaching to the base of the femora; a very small superior antehumeral spot on either side. Laterally, from immediately behind the humeral suture, the thorax is yellow marked with a black line which rises below at the level of the first lateral suture, includes the stigma, curves backward to join a second black line which follows the course of the second lateral suture, but bifurcates above to enclose a small yellow space.

Abdomen black marked with yellow; 1 with a lateral spot on either side; 2 with a dorsal triangle, its apex directed backwards covering the first two-thirds of the segment, sides including the auricles also yellow; 3-7 each with a fine yellow, basal, transverse mark dorsally, occupying about the first eighth of the length of the segment; 8 entirely black; 9 with the trace of a yellow ring at its apex; 10 entirely black.

Legs black, the first pair of femora yellow on their inner side, the second pair with a small yellow mark on the same surface distally.

Appendages black. The genital structures on 2 are almost identical with those shown in Williamson's figure (Williamson, *loc. cit.* fig. 28 c), the second pair of hamuli not quite so prominent.

Anal appendages relatively shorter, the limbs of the lower one stouter and less divaricate (*loc. cit.* fig. 28, A, B. Cf. also Martin, quoted by Williamson, *loc. cit.* p. 301).

[Ris *loc. cit.* has recently described a species from Java which he refers to this genus under the name *B. jacobsoni*. This species differs from *B. vermiculatus* in the colouring of the thorax, in the shape of the genital hamuli, and of the anal appendages. It is also a little larger.

He is inclined to regard the form described by Williamson as distinct from the true *B. vermiculatus* of Martin.]

The specimen described above is deposited in the British Museum.

HETEROGOMPHUS ICTEROPS Martin, subsp. BORNEENSIS, nov.? (Pl. I. fig. 3.)

Heterogomphus icterops Martin, Mission Pavie, p. 9 (sep.); id., Bull. Mus. d'Hist. Nat. 1902, no. 7, p. 506; Williamson, *loc. cit.* p. 316.

1 ♂. Matang Rd. 28:3:10.

Length of abdomen (without appendages) 51 mm.

Length of hind wing 45 mm.

The cross-nerves on the wings on the right side of the single specimen are highly irregular; it would seem as though that during development those wings had suffered from a "cell-storm" which did not interfere with the general symmetry of the wings nor yet largely with their main structural features, but considerably disturbed the number and arrangement of the cross-nerves, especially on and near the costal spaces.

Martin's description of the species, based on an example in de Selys' collection, from Java, is very brief. Hence, without actually confronting the specimens, it is impossible to say how far the Bornean form here described is distinct.

Venation:—

16—22!	13—13
An.n. ———	Pn.n. ———
13—15!	12—15

In addition, there are several incomplete antenodals on the right fore wing, and two cross-nerves in the submedian space, whilst there is also a single cross-nerve in the supra-triangle of the hind wing of that side.

The pterostigma has a well-developed brace on all four wings.

Head: With the exception of the vertex and occiput which are very dark brown, and of the eyes which in the dead specimen are brown, the head is light brownish yellow in colour; the *prothorax* is brown, lighter at the sides.

The *thorax* is yellow marked with brown as follows:—A broad humeral band continuous above with the brown of the antealar sinuses and below with a narrow stripe running along the anterior margin of the mesothorax; a broad band runs down along the mid-dorsal carina, narrowing below and just meeting the posterior

margin of the mesothoracic half-collar, but not coalescing with the brown stripe along its anterior border. Laterally, there is a narrow stripe along the second lateral suture continuous over the back.

Legs: Femora red-brown, tibiae and distal parts black.

Abdomen rather pale brown, each segment, excepting the first two and the last two, having a black ring distally. 1, 2 are largely yellow at the sides and have yellow markings dorsally; in 1 this is confined to the posterior half of the segment, except for a very fine line extending forwards to the anterior end of the segment in the mid-dorsal line. In 2 the dorsal yellow colour takes the form of an irregular longitudinal band. On 7 the brown of the anterior three-fifths of the dorsum of the segment carries a square yellow mark. 9, 10 are unmarked, 9 dark brown, 10 lighter. The latter segment is very short, not half the length of 9.

Anal appendages light brown, the extreme points finely tipped with black. In general resembling those of *H. smithi* Selys, long and slender, the upper pair as long as 9, 10 together, the limbs of the lower appendage about four-fifths as long. The upper pair are straight, their tips hooked downwards to a very trifling extent. The limbs of the lower appendage are also straight, except at their apices which have a slight curving upwards, whilst each carries at about one-sixth of its length from the apex a small sharply-pointed spur, directed inwards at a right angle to the axis of the limb.

This large and handsome insect represents a genus new to the fauna of Borneo, and is one of the most interesting of Mr. Moulton's many "finds" amongst the Odonata of the island.

The specimen will be deposited in the British Museum.

Subfamily CHLOROGOMPHINÆ.

In describing the venation of the species of this subfamily, I use the term "anal loop" to indicate the very definite area lying below the cubital space bounded by branches of the anal vein and by $An_1 + Cu_2$. The name is used in the same sense by Needham (Proc. U.S. Nat. Mus. xxvi. p. 733) for *Chlorogomphus*. The loop, as well as the area between Cu_2 and An_1 in the hind wing, seems liable to considerable individual variation in the genus.

I have figured the penis of *Orogomphus dyak* (Pl. I. fig. 7), and would call attention to its close resemblance to that of *Cordulegaster*. The structure of the antennæ is also well worth remark.

Ris has noted the occurrence of tibial ridges in the males of this subfamily (Ris, Coll. Zool. Selys, ix. p. 9, 1909). These ridges, so far as one can judge, are scarcely adaptive structures, and their presence would appear to me to indicate a real if remote relationship to the Corduliinæ.

OROGOMPHUS DYAK Laidlaw. (Pl. I. figs. 4-7.)

Orogomphus dyak Laidlaw, Journ. Straits Branch R. Asiatic Soc. 1910, p. 121 (1911).

♂ ♂.

Venation :—

The triangles of the hind wings have their upper and outer sides subequal, the inner side distinctly shorter, resembling that of the fore wing.

Formula :—

	Anal loop of hind wing.	An.n.	Pn.n.	M.	Cu.	t. (cells).	suprat.
		21—21	11—12	3—3	7—7	1—1	5—5
♂ ₁ (type)...	7—7	18—16	15—15	3—3	6—7	1—1	5—4
		21—24	11—11	3—3	8—6	1—1	5—4
♂ ₂	8—6	16—18	12—13	3—3	7—7	1—1	5—4

The wings have a slightly yellow tinge, most marked when seen with reflected light, between Cu and M₂ proximal to the pterostigma, especially in the specimen marked ♂₂.

Head: Labium brownish yellow, labrum black; rhinarium dark brown, nasus bright lemon-yellow; frons black, but with a fine yellow line along the crest which is surmounted by a number of fine black hairs, not so numerous as in *O. atkinsoni*. Vertex and occiput jet-black. Ocelli and antennæ as in *O. atkinsoni*.

Prothorax black above, the posterior margin edged with yellow, and the same colour on the sides.

Thorax relatively small, black, marked with yellow lines. On either side is a narrow dorsal thoracic stripe, widening a little at its extremities, touching the mesothoracic half-collar below, a little curved with its convexity inwards; followed by a broader antehumeral stripe. There is a narrow stripe laterally on the metepisternum, and the metepimeron is finely edged with yellow; the under surfaces are brownish, and there is a yellow interalar spot and a fine yellow spot on each alar sinus.

Legs black, coxæ and base of under side of femora of the first pair yellow.

Abdomen black, marked with golden yellow as follows:—A fine transverse line at the distal end of 1; the distal half of 2, but this is largely obscured by a broad transverse black band lying within it; the auricles are yellow. There is a very small pair of lateral spots about the middle of 3, and a small terminal transverse spot on the same segment. On 6 there is a terminal ring, occupying about the last one-eighth of the length of the segment.

The anal appendages are black, rather longer than 10. They resemble generally those of *O. splendidus* as figured by Dr. Ris, but differ in detail; the upper pair is much slenderer than in that species and has the ventral teeth much smaller; the lower

appendage is much less deeply cleft and its limbs are pointed, not truncate.

♀ ♀. Matang Rd.

In details of venation these two specimens differ considerably from one another.

Formula:—

	Anal loop (hind wing).	An.n.	Pn.n.	M.	Cu.	t. (cells).	suprat.
A (type) ...	<u>10—10</u>	<u>22—23</u>	<u>12—11</u>	<u>3—3</u>	<u>8—7</u>	<u>2—2</u>	<u>5—6</u>
		19—20	14—14	3—4	9—9	3—3	6—6
B	<u>14—14</u>	<u>22—22</u>	<u>12—10</u>	<u>3—3</u>	<u>8—9</u>	<u>2—2</u>	<u>5—5</u>
		20—20	14—15	4—3	9—9	3—3	6—5

The difference is most marked in the anal area. Not only is the number of cells here greater in specimen B than in A, but there is also a marked difference in the number of cells lying between the fork of Cu_2 : in A these cells lie in two rows, and, excluding the marginal cells, are 9 in number; in B, on the other hand, they are disposed in three rows and number 13 and 11.

As in the males the inner side of the triangle of the hinder wings is the shorter, though in this sex the difference is not very strongly marked.

The type-specimen, A, evidently the more mature, has the wings suffused with a golden-brown tinge throughout; most marked at the bases and apices. The colour is richest about the periphery of the cell, the central part, especially at the apices of the wings, being often distinctly paler. B, the younger specimen, has the wings almost colourless, but with a very faint yellow tinge between the nodus and pterostigma extending down the wing as far as M_2 .

The colouring of the head, thorax, and body scarcely differs from that found in the male.

The following are the principal measurements:—

Length of abdomen: ♂ 53 mm., ♀ 56 mm.

Length of hind wing: ♂ 38 mm., ♀ 42 mm.; breadth ♀ 14 mm.

In both sexes a basal postcostal nerve is present.

Type ♂ & ♀ will be deposited in the British Museum.

OROGOMPHUS SPLENDIDUS de Selys. (Pl. I. fig. 8.)

Orogomphus splendidus Selys, 4^{me} Addition Synops. Gomph. p. 681 (1878); id. Anal. Soc. Españ. Hist. Nat. xi. p. 16 (1882); Kirby, Cat. Odonata, p. 79; Martin, Mission Pavie, p. 14 (sep.) (1904); Williamson, loc. cit. p. 278 (1907); Ris, Suppl. Entom. Deutsch., Ent. Mus. No. 1, 1912, pp. 77, 79, fig. 15 a, b, Taf. iii. figs. 1–6, Taf. v. fig. 5.

Mr. Moulton has forwarded me two female specimens presumably belonging to one and the same species though showing

some rather marked differences in venation. These two specimens are, I believe, to be referred to *O. splendidus* de Selys. It is evident from Ris' study of the venation of three males belonging to this species, that there is a considerable amount of individual variation to be looked for, and the agreement between them and de Selys' type is close in other respects.

One of the specimens has been returned to the Sarawak Museum, and unfortunately I did not before returning it make full notes of the venational formula for both pairs of wings.

	Anal loop (hind wing).	An.n.	Pn.n.	M.	Cu.	t. (cells).	suprat.
1.	—	—26	—13	—2	—9	—3	—5
	—20	—19	—16	—3	—8	—3	—4
2.	—	26—25	14—13	3—2	8—8	2—2	5—5
	13—14	20—18	17—18	2—2	8—8	3—3	5—4
(de Selys' type.)	—	23—25	14	3	6—7	3	5—6
	—	—	—	—	—	—	—

The most marked difference between Mr. Moulton's specimens is in the anal loop. In Ris' photograph of the type ♂ from Kosempo that area contains 19 cells.

Further, in Moulton's specimens in 1. there are only 2 rows of cells in the space between Cu_2 and A, almost to the margin of the wing, whilst in 2. there are on the right side 4 rows and on the left 6 rows; in the type male there appear to be 6 rows.

The wings of the Bornean specimens are coloured as follows:—Base and apices of wings suffused with bright golden brown, on the fore wing reaching to the inner angle of the triangle, and on the hind wing one cell beyond the arculus; at the apices the colour begins rather nearer to the pterostigma than to the nodus, and is fainter on the anal margin of the wing.

The basal postcostal nerve is absent in these female specimens; it is present in the male figured by Dr. Ris.

The colouring of the head, thorax, and body is as described for the male.

The chief measurements are:—

Length of abdomen circa 56 mm.

Length of hind wing 48 mm.; breadth 17·5 mm.

[*OROGOMPHUS ATKINSONI* de Selys.*

Orogomphus atkinsoni Selys, 4^{me} Add. Synops. Gomph. p. 682 (1878); Kirby, Cat. p. 79; Selys, Ann. Mus. Civ. Genova, 2. x. (p. 49 sep.) (1891); Williamson, loc. cit. p. 278, figs. 5, 6 (1907).

1 ♀, Bhowali.

(Indian Forest Research Institute per Dr. Imms.)

* Not recorded from Borneo.

The following is an account of the single specimen of this species that I have been able to examine :—

Venation : The triangle of the hind wing, as in the specimen figured by Williamson from the de Selys collection, has its upper and inner sides subequal, distinctly shorter than is the outer side. The male, judging from Williamson's figure, has the inner side distinctly shorter than the other two sides, so that the apex of the triangle is at its outer angle.

The triangles of the hind wings in my specimen are bisected in each wing by a nerve running from its inner angle to the middle of the outer side, whilst in de Selys' specimen, on the left side at any rate, the triangle is divided into 3 cells. Otherwise the venation agrees in detail between the two specimens. There is no basal subcostal nerve.

The wing-formula of the two female examples is as follows :—

	Anal loop of hind wing.	An.n.	Pn.n.	M.	Cu.	t. (cells).	suprat.
Bhowali, Kumaon.....	<u> </u>	<u>19—19</u>	<u>9—10</u>	<u>1—1</u>	<u>6—7</u>	<u>2—2</u>	<u>3—3</u>
	10—10	14—13	12—12	1—1	6—6	2—2	3—3
Bengal. Coll. Selys. } (From Williamson's figure.) }	<u> </u>	<u>19—</u>	<u>12—</u>	<u>1—</u>	<u>7—</u>	<u>3—</u>	<u>3</u>
	12—	15—	13 (?)	1—	8—	3—	3 (? 4)

The wing-formula of the male is

Bengal. Coll. Selys. } (From Williamson's figure.) }	<u> </u>	<u>20—</u>	<u>10—</u>	<u>1—</u>	<u>7—</u>	<u>2—</u>	<u>3—</u>
	9—	13—	14—	1—	5—	2—	2—

In the specimen from Bhowali the extreme base of both pairs of wings has a golden tinge, this does not extend so far as the first cross-nerves.

Head : Labium dull brown. Labrum brown edged with black. Rhinarium dark brown; nasus and frons brownish yellow, the frons at its vertex carries a line of fine black hairs, and is as high as the summit of the occiput. In front it is rather flattened. Vertex black; the ocelli lie in a slightly curved line, the median one being placed a little in advance of the lateral pair.

The antennæ have the second joint relatively very large and stout, cylindrical in shape, and equal in length to the distal part of the organ which consists of five or six slender joints. The large brown eyes meet at a point; and the occiput is small, dark brown in colour, with a fringe of fine yellow hairs.

The *prothorax* is small, dark brown above, its posterior margin lemon-yellow.

The *thorax* is relatively small, black, and thickly covered with silky brown hairs; there is a pair of dorsal humeral stripes, rather wedge-shaped, with their apices directed forwards, not quite touching the margin, of a bright lemon-yellow colour. Two broad bands of the same colour lie on either side of the thorax,

the first on the mesepimeron, the second, the broader, on the metepimeron; the under surfaces are brown, and there is a yellow spot on the interalar sinus.

The *legs* are black, the coxæ and base of under surface of the first pair are lemon-yellow.

Abdomen: Segments 1, 2, 3 and 5, 6, 7 a little dilated. Black with golden-yellow markings as follows:—A fine transverse band at the distal end of the dorsum of 1. The terminal half of 2, but this band carries a black median dorsal spot, which has rather the shape of a three-pointed ivy-leaf directed backwards, the yellow band is also incomplete below. 3, 4, 5 with a pair of lateral spots at their middle, and a terminal half-circle, interrupted by the mid-dorsal carina. 6, 7, 8, 9 with the terminal half-circle only.

Measurements of specimen from Bhowali:—

Length of abdomen 57 mm.; hind wing 42·5 mm.

Length of pterostigma 3 mm.; width of head 9 mm.

Breadth of wing 15 mm.]

NOTE.—I have omitted from the list *Macrogomphus abnormis* de Selys as its provenance is doubtful.

EXPLANATION OF THE PLATE.

- Fig. 1. *Ictinus acutus*, sp. n. Superior anal appendages of male, seen from above.
 2. *Burmagomphus vermiculatus* (Martin), *insularis* subsp. n. Thoracic colour pattern (diagrammatic).
 3. *Heterogomphus icterops* Martin, *borneensis* subsp. n.?
 4. *Orogomphus dyak* Laidlaw. ♂, wings of left side.
 5. " " " ♀, wings of left side.
 6. " " " ♂, anal appendages.
 7. " " " ♂, penis and vesicle.
 8. *Orogomphus splendidus* de Selys. ♀, wings of left side.

(For the photographs from which figs. 3, 4, 5, and 8 are reproduced I am indebted to the kindness of Messrs. F. W. & H. Campion.)

5. Note on an imperfectly developed specimen of the Sea-Urchin (*Echinus esculentus*). By H. C. CHADWICK, A.L.S.*

[Received October 30, 1913 : Read February 17, 1914.]

(Text-figures 1-4.)

The subject of this note was collected and handed to me for description by Prof. W. J. Dakin, who found it upon the ruined breakwater at Port Erin during the autumn of 1912. Prof. Dakin's attention was attracted to it by two well-marked depressions in the test, which were evident while the animal was living and covered with spines. The depressions are in interambulacra 1 and 4; and, denuded of its spines, the test presents the appearance of a lump of plastic material which has been pinched by the thumb and forefinger. The spines of the entire test were distinctly larger and more densely crowded than those of a normal specimen of the same size from the same locality.

The apical system presents two abnormalities. Genital 4 is of normal shape, but consists of two distinct plates united by suture. Two closely approximated but distinct pores occupy the position of the normal one on genital 1.

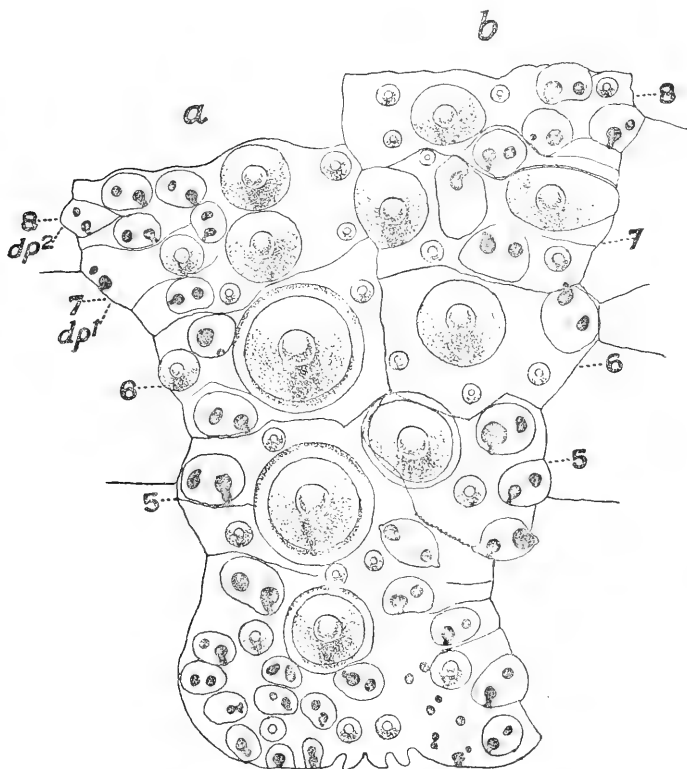
As shown in text-fig. 1, the composition of the first seven or eight plates of both series in ambulacrum II is irregular, that of the first four especially so. The plates numbered 5 and 6 respectively in series *a* appear to be composed of two primaries, the adoral of number 5 being imperforate. In the case of the elements which I have interpreted as plates 7 and 8, I conclude that dp^1 is the demi-plate of plate 7; and but for the complete reversal of the position of the pores of the pair borne by the small plate lying between it and the aboral primary of plate 6, this might have been regarded as the adoral primary of the same plate. dp^2 is probably the demi-plate of plate 8. The first recognisable plate in series *b* is most probably number 5. Number 6 is clearly defined, but there are no traces of sutures to indicate its composition. The position of the single pore-pair suggests that it is that of a demi-plate. Number 7 appears to consist of two primaries without a demi-plate. The peripode of the element which I have interpreted as the aboral primary lies at right angles to the normal position and encloses only one pore. It is, however, possible that the pore-pair which lies aborally and to the right of this may be an element of plate 7, and that the large ellipsoid tubercle occupies the position of the pore-pair of the demi-plate. Should this view be correct, the next plate, number 8, is practically a normal one.

Proceeding now in the direction of the apical pole, all the

* Communicated by Dr. F. A. BATHER, F.R.S., F.Z.S.

plates of series *a* are normal until number 46 is reached. Then follow a series which, regarded from their inner, tuberculate ends, apparently number seven plates, and which exhibit striking irregularity of composition (text-fig. 2). It may be that the two numbered 47 and 47 *a* respectively compose one but slightly imperfect plate, that portion of the suture which traverses the large tubercle, and is represented by the dotted line, being

Text-figure 1.

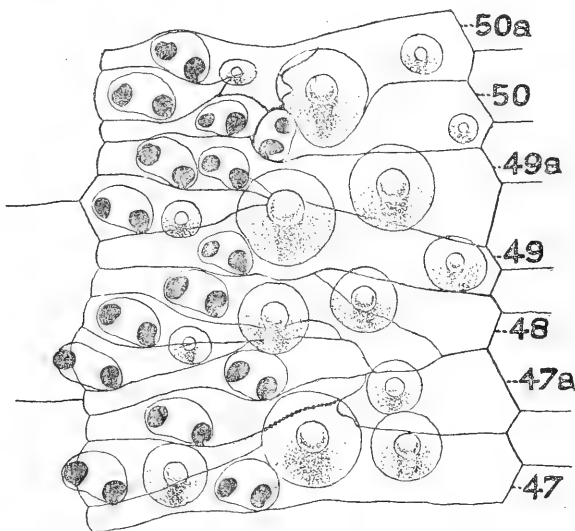


Oral end of ambulacrum II. The Arabic numerals indicate the numbers of the plates, reckoned from the peristome. *a* and *b*, series in ambulacral area.

obscure. Number 48 consists of five elements, none of which ranks among the primaries, while only one is imperforate. The next two plates are numbered 49 and 49 *a* respectively, on the assumption, which the positions of three of the pore-pairs supports, that they represent one ordinary plate. The appearance of the next plates, numbered 50 and 50 *a* respectively, suggests that they also

represent one ordinary plate. The presence of a fourth pore-pair in this and the preceding plate is difficult to account for, except on the assumption that both represent small interpolated elements.

Text-figure 2.

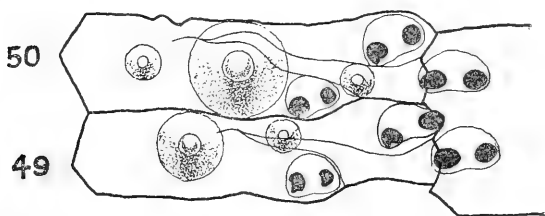


Abnormal plates in series *a* of ambulacrum II.

For explanation of lettering, see text-fig. 1.

In series *b* of ambulacrum III (text-fig. 3) plates 49 and 50, while of normal composition, are exceptional in that the pore-

Text-figure 3.

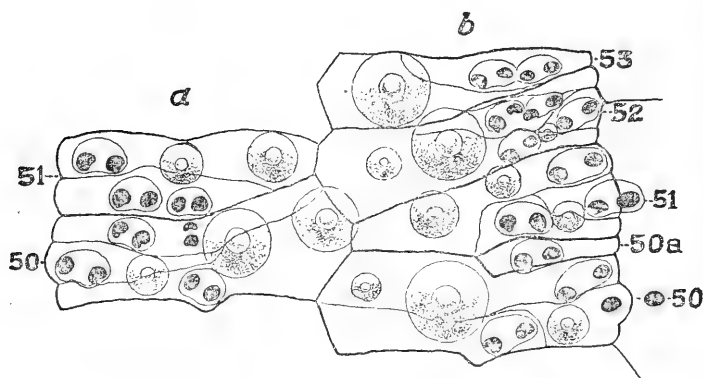


Abnormal plates in series *b* of ambulacrum III.

pairs of their respective demi-plates are almost completely outside the limits of the plate, and perforate the adjoining interambulacral plate.

Similar irregularities, though not so well marked, occur in plates 50 and 51 of series *b* of ambulacrum IV (text-fig. 4). In this ambulacrum the presence of a fourth pore-pair in plate 50

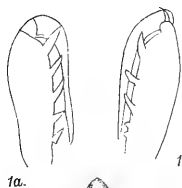
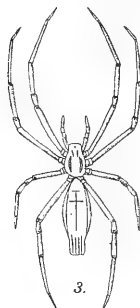
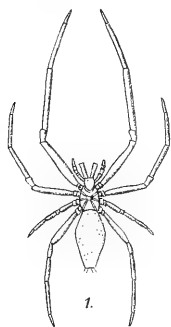
Text-figure 4.



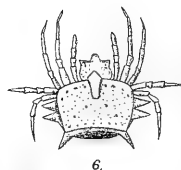
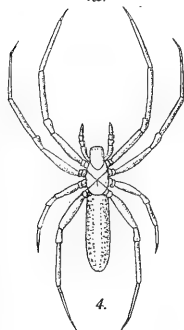
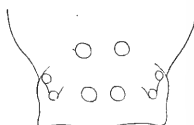
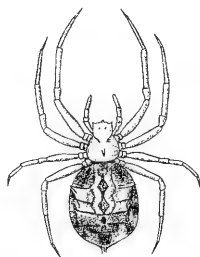
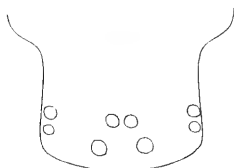
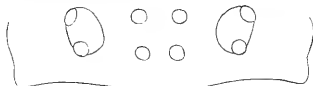
Abnormal plates in series *a* and *b* of ambulacrum IV.

in series *a* and plate 52 in series *b* again suggests the interpolation of small and obscure elements. No. 52 in series *b* undoubtedly has an interpolated demi-plate.



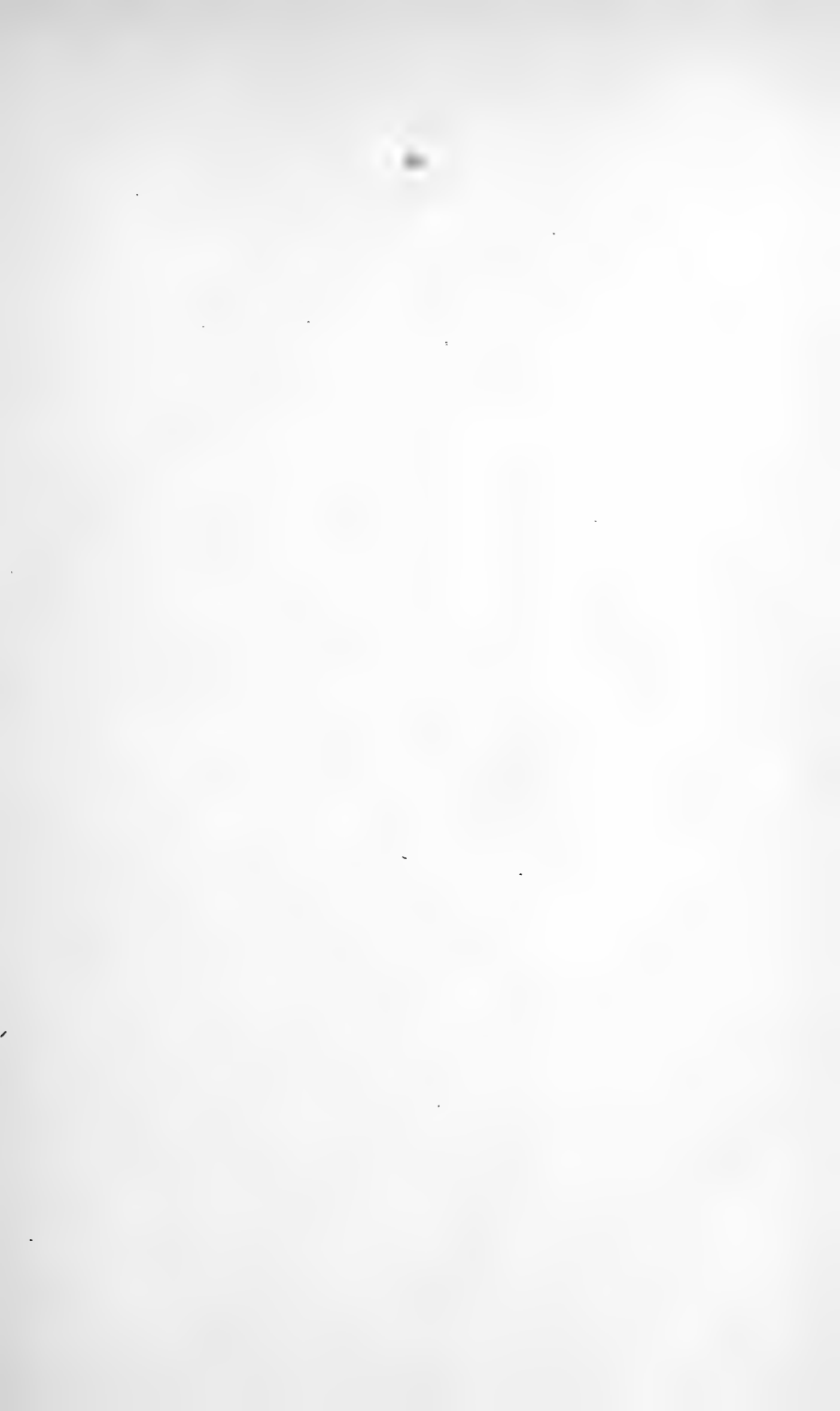


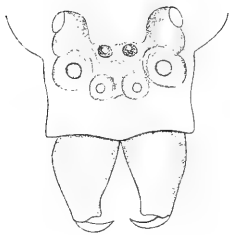
1b.



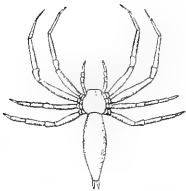
5d.







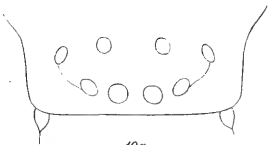
7a.



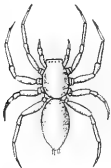
7.



7b.



10a.



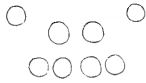
10.



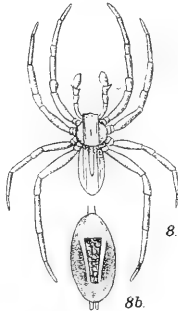
10b.



10c.

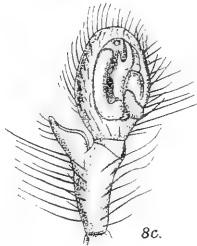


8a.

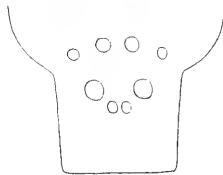


8

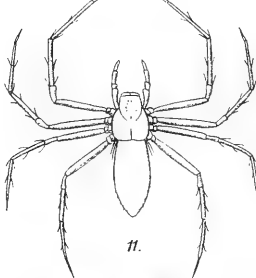
8b.



8c.



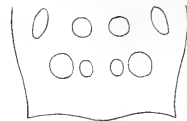
11a.



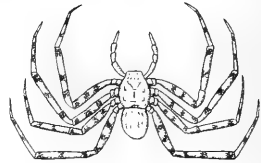
11.



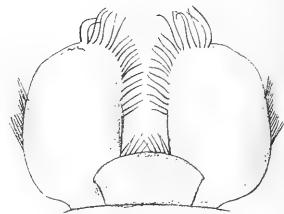
11b.



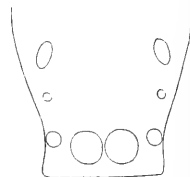
9a.



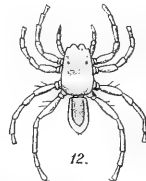
9.



9b.



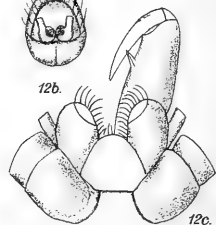
12a.



12.



12b.



12c.

6. Spiders from the Montebello Islands.

By H. R. Hogg, M.A., F.Z.S.

[Received December 22, 1913: Read March 3, 1914.]

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The collection of Spiders hereunder described was made partly by Mr. P. D. Montague, and partly by Mr. T. H. Haynes. By the kindness of these gentlemen they have been placed in my hands.

The Montebello group is situated on the N.W. coast of Australia, off the Port of Onslow, W. Australia, the largest, Hermite Island, being 90 miles from the mainland, in lat. 20° 30' S., long. 145° 15' W.

Mr. Montague visited the islands for the purpose of collecting specimens of the fauna, and Mr. Haynes lived on Hermite Island for about three years, until driven off by a hurricane which destroyed his hut and a larger collection which he had been good enough to make at my request.

Mr. Haynes informs me that the soil consists of sandstone-rock, similar to that on the mainland, of which therefore the islands were probably part, and the S.E. winds prevailing for the six winter months blow off the land.

It will be noticed that by far the larger number, both of species and specimens, are of the family Argiopidae, with a small sprinkling of Lycosidae, Thomisidae, Clubionidae, Oxyopidae, and Attidae.

* For explanation of the Plates see p. 92.

Notable absentees are *Delena cancerides* Walck., and *Latrodectus hasseltii* Thor., found generally in every part of Australia, but no specimens have been brought from here.

Family ARGIOPIDÆ.

Subfamily TETRAGNATHINÆ.

Group TETRAGNATHÆ.

Genus TETRAGNATHA Latreille.

TETRAGNATHA ANGULATA, sp. n. (Pl. I. fig. 1.)

A single specimen (P. D. M.).

Female. The cephalothorax is greyish yellow, with broad darker depressions separating the cephalic from the thoracic part and broad dark grey radial lines from the margin of the cephalothorax to a transverse broad oval depression, one-third of the distance between the end of the cephalic part and the rear end of the thoracic, also dark grey round the margin of the thoracic part; it is sparsely covered with short, fine, white hairs. The eyes are yellow on black ground. Mandibles yellow tinged with dark grey at the sides, and with a few white hairs. Fangs yellow-brown. Sternum rather dark yellow-brown. The lower part of the lip the same. The upper margin of the lip and the maxillæ are bright yellow with light brown fringes. Legs and palpi pale yellow with brown spines, rising from brown patches. The abdomen above is greyish yellow, with a mottling of darker grey, pale yellow below with a broken median darker yellow stripe.

The cephalothorax is twice as long as broad, convex, narrowed in front, rounded at the sides, and slightly hollowed at the rear end.

The rear row of eyes is straight, or slightly recurved when seen from above, of equal size, the median $2\frac{1}{2}$ diameters apart and 3 diameters from their laterals, which are their diameter away from the front laterals. The front row, more strongly recurved, has the laterals only half the diameter of the rear, lying on the same tubercle therewith. The front median are rather larger than the rear, $1\frac{1}{2}$ times their diameter apart, and the same from the rear, so that they form a quadrilateral, broadest posteriorly; they are one-half their diameter from the margin of the clypeus, which overhangs the insertion of the mandibles. These are divergent, projecting forward, kneed at the base. On the outer margin of the falx-sheath are five teeth at equal intervals apart, the upper one situated at the anterior inner corner is the largest, the others diminishing in order of sequence. On the under side the upper one is similarly placed, followed by two rather smaller, at intervals of their length, and then three quite small close together.

The maxillæ are rather divergent, truncate, and broadest

anteriorly, three times the height of the lip, which is broader than long, rounded in front, straight at the sides with the upper margin clearly protrudent. The sternum is shield-shaped, $1\frac{1}{2}$ times as long as broad; from its greatest breadth between the second pair of coxæ it narrows slightly anteriorly and posteriorly to a point between the not quite contiguous rear coxæ. The legs are long and thin, the metatarsi and tarsi tapering to a very fine point. The abdomen is twice as long as broad, widening from the base to halfway of its length, whence it rather suddenly narrows and tapers to the spinnerets. The epigyne is dome-shaped on the upper half, overhanging two oval hollows, one each side of a median broad ridge.

This species is rather near L. Koch's *T. gemmata* from Port Mackay, but is smaller; the first pair of legs not so long compared with the second, and the mandible on the upper side is without the large tooth near the middle of the anterior edge; the coloration is much lighter, and there are brown spots on the legs.

The measurements (in millimetres) are as follows:—

		Long.	Bread.			
Cephalothorax...		2	1			
Abdomen.....		4	2			
Mandibles		$1\frac{1}{4}$				
		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.	
Legs	1.	$\frac{3}{8}$	4	5	4	= $13\frac{3}{8}$
	2.	$\frac{1}{4}$	3	3	3	= $9\frac{1}{4}$
	3	$\frac{1}{4}$	$1\frac{1}{2}$	1	$1\frac{1}{2}$	= $4\frac{1}{4}$
	4.	$\frac{3}{8}$	3	$2\frac{1}{2}$	3	= $8\frac{7}{8}$
Palpi		$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{8}$	= $1\frac{1}{2}$

Subfamily NEPHILINÆ.

Group NEPHILINÆ.

Genus NEPHILA Leach.

NEPHILA VENOSA L. Koch.

8 females (2 non-adult), P. D. Montague.

Hab. (sec. *Rainbow*). Polynesia, New Guinea, Torres Straits, Queensland, N. S. Wales. Victoria and S. Australia (*H. R. H.*).

In these specimens the eyes of the rear row are clearly smaller than those of the front row, whereas in L. Koch's description they are of the same size. This is also the case in my specimens from S. Australia. The longitudinal lines on the rear end of the abdomen are also absent, but the specimens agree in other respects; and I see no reason for making them a local variety, which they might be said to be if only found on this particular island.

NEPHILA MERIDIONALIS Hogg, var. *HERMITIS* nov. (Pl. I. fig. 2.)

Trans. Royal Soc. of S. Australia, vol. xxxiv. 1910, p. 59*.

4 females, T. H. 10 females (6 non-adult), P. D. M.

These correspond in almost every particular with my *N. meridionalis* from Kangaroo Island, S. Australia.

They differ, however, in having the distance between the rear row of median eyes rather greater than that between the front median instead of the same; in the clypeus $1\frac{1}{2}$ times as wide as the distance between the front median eyes instead of equal to it; and the pale lines forming the pattern on the under side of the abdomen much finer. There are also two small black spots behind the eyes and two more on the margin of the cephalic part. I have therefore made it a new variety: *hermitis*.

The measurements (in millimetres) are as follows:—

		Long.	Broad.			
Cephalothorax...		12	{ 6 in front. 8			
Abdomen.....		14			9	
Mandibles		5				
			Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.
					4 & 11	
Legs	1.	$2\frac{1}{2}$	17	15	21	= $55\frac{1}{2}$
	2.	$2\frac{1}{2}$	15	13	19	= $49\frac{1}{2}$
	3.	$1\frac{1}{2}$	9	6	$9\frac{1}{2}$	= 26
	4.	2	14	10	$14\frac{1}{2}$	= $40\frac{1}{2}$
Palpi	1		4	4	3	= 12

Tibia longer than patella.

Another specimen measures:—

		Long.	Broad.			
Cephalothorax...		10	{ 5 in front. $7\frac{1}{2}$			
Abdomen.....		13			8	
Mandibles		$4\frac{1}{2}$				
			Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.
Legs	1.	$2\frac{1}{2}$	16	15	21	= $54\frac{1}{2}$
	2.	$2\frac{1}{2}$	15	13	19	= $49\frac{1}{2}$
	3.	2	9	7	10	= 28
	4.	$2\frac{1}{2}$	14	10	15	= $41\frac{1}{2}$
Palpi	1		4	4	4	= 13

Differing very slightly from the original type-specimen.

Another, with a cephalothorax 9×7 mm., has the abdomen 20×14 mm., apparently full of eggs.

* The length of the cephalothorax in my original description is misprinted $14\frac{1}{2}$ for $10\frac{1}{2}$ millimetres.

Subfamily ARGIOPINÆ.

Group ARGIOPEÆ.

Genus ARGIOPE Aud.

ARGIOPE TRIFASCIATA Forskål.

13 females, P. D. M. 3, T. H.

Widely spread over Northern Australia, the Pacific Islands, and many other tropical and subtropical parts of the world.

ARGIOPE HAYNESI, sp. n. (Pl. I. fig. 3.)

This species, of which Mr. Haynes sent 10 females, is closely related to L. Koch's *A. protensa* and *A. syrmatica*, though it differs from them both more than they do from one another, and I have therefore named it as new.

The cephalothorax is yellowish grey, thickly covered with smooth silvery grey hairs all over the thoracic part, and in a median longitudinal area between the eyes and at the sides of the thoracic part the darker under coloration shows through, but there are no definite dark longitudinal lines as in *protensa* and *syrmatica*.

The mandibles are dark grey at the base and on the outer sides, rather bright yellow on the inner and anterior portions. The fangs red-brown at base and pale red forward. The lip and maxillæ are bright yellow on the upper half, brown below. The sternum is black-brown, with fine downlying grey hairs at the sides, and a thickly haired yellowish-white median area reaching the whole length.

The abdomen is silvery white with fine white hairs on the upper side; a narrow black longitudinal line, running from the base to rather more than halfway, with two transverse lines at the upper end, like a Russian cross. There are no longitudinal lines at the posterior end. The base of the under side is yellow at the sides and dark grey* in the middle. The dark area is continued in a broad median stripe to the spinnerets, bordered on each side by a white network-patterned area, which passes behind the spinnerets, the dark stripe being continued to the posterior end, as in *A. protensa*, but not in *A. syrmatica*. The sides are dark grey with pale yellow longitudinal lines.

The legs are darkish yellow, with long brown spines and grey hairs. The anterior half of the metatarsus and the whole of the tarsus of all legs have short brown bristly hairs. The front of the patella and base of the tibia is dark brown. Near the anterior end of the tibia is a brown ring, and the anterior end of same and base of metatarsus are likewise covered by a brown spot. The under side of femur 1 is dark grey.

The cephalothorax, one-third longer than broad, is rounded at the sides, the cephalic part, narrow and short, being divided by well-marked depressions from the thoracic. It does not reach to the median fovea, which is short and recurved. The whole

area is rather flat and covered with particularly smooth long hairs all lying longitudinally.

The front row of eyes is straight, the median pair their diameter apart and $1\frac{1}{2}$ times the same distance from the laterals, which are only half their diameter. These are also their diameter from the rear laterals, the diameter of the latter being half as large again, and farther away, sideways, by the breadth of the front laterals. The rear median are the same size as the front median, two diameters therefrom and $1\frac{1}{2}$ diameters from one another. Therefore they form with their laterals a strongly procurved row.

The mandibles are short and conical, only slightly kneed at the base and divergent at the anterior end. The fangs are slightly curved and rather long. On the upper part of the outer margin of the falx-sheath is one long tooth between two shorter, and on the inner in the same position three also, the lowest being the largest.

The maxillæ are convex, as long as broad, obtusely arched on the upper edge and rounded at the back. The lip is broader than long, curved to an obtuse angle in front, where it is very convex, with a short narrower lower stem.

The sternum is shield-shaped, scoloped at the sides, half as long again as broad; opposite the second and third coxæ the median area is projected into high round protuberances, and at the posterior end is a similar but still larger oval knob. The hair is downlying, finer at the sides than in the middle streak, and there are a few long bristles at the anterior end.

The abdomen is $2\frac{1}{2}$ times as long as its breadth in the middle, whence it tapers to a narrow rounded point at each end. On the under side the base is less constricted and more rounded off, the sides are straighter until beyond the spinnerets, where it is suddenly narrowed into a stunted tail. On the back are four pairs of muscle-spots.

The epigyne is formed in the same unique fashion as in *A. protensa* and *A. symatica*, a chitinous cushion-like pear-shaped projection, broadest at the base and having a blunt oval fore end, standing straight up. The basal end is about one-third of the whole breadth of the abdomen at that part.

The legs are rather long and very fine in the anterior joints, the tibia broadened out and flattened at the anterior end, and the trochanter of the fourth pair nearly as long as the coxæ.

The femoral joint of the palpi is strongly incurved, and broadest at the anterior end. The tibia is twice as long as the patella, and, the metatarsal joint is covered with long bristly hairs.

The measurements (in millimetres) are as follows:—

	Long.	Broad.
Cephalothorax...	4	$\left\{ \begin{array}{l} 1\frac{1}{4} \text{ in front.} \\ 3 \end{array} \right.$
Abdomen.....	10	4
Mandibles	$1\frac{1}{4}$	

		Coxae.	Tr. & fem.	Pat. & tib.	Metat. & tars.	
Legs	1.	1	7	$6\frac{1}{2}$	$8\frac{1}{2}$	= 23
	2.	1	7	6	8	= 22
	3.	$\frac{3}{4}$	$4\frac{1}{2}$	3	$4\frac{1}{2}$	= $12\frac{3}{4}$
	4.	$\frac{3}{4}$	7	5	7	= $19\frac{3}{4}$
Palpi		$\frac{1}{2}$	2	$1\frac{1}{4}$	$1\frac{1}{2}$	= $5\frac{1}{4}$

The obvious difference between this species and *A. protensa* and *A. symmatica*, which latter are very much alike, is the shortened tail, the absence of the dark longitudinal markings on the cephalothorax and of the longitudinal markings on the posterior end of the upper side of the abdomen, almost every other point being the same or very slightly modified in the three species.

In the somewhat allied genus, *Arachnura* Vins., several species have been constituted on the differences of the knobs at the end of their tails and of their shoulder-humps. Oftentimes these differences are seen in spiders of the same group of webs, and the spiders are possibly all derived from the same batch of eggs. I am not satisfied that this does not occur in the above species, the two first named being both described from the same locality, Port Mackay, in Queensland. The differences between them, if any, are very trifling.

Group MANGOREÆ.

Genus LARINIA Simon.

LARINIA MONTAGUI, sp. n. (Pl. I. fig. 4.)

2 females, P. D. M. 1 female, T. H.

Cephalothorax pale yellow, with a slightly darker median longitudinal streak and thinly spread white hairs. Mandibles the same, with pale yellow-brown fangs. Maxillæ and upper half of lip pale yellow, but base of latter light brown. Sternum pale yellow in median area, with light yellow-brown along the sides and at the lower end. Legs and palpi similar pale yellow, with fine white hairs, light brown spines on brown roots, and brown bristles on tarsus and metatarsus. On femur 1 the brown spots are much more numerous than elsewhere.

The abdomen above is pale yellow with white hairs and white upstanding bristles, but mottled with darker brown in patches, giving the whole a uniform dark appearance. On the under side it is a network of paler and darker yellow. The spinnerets are brighter yellow, and the epigyne brown with yellow in the hollows and an oblong grey area behind it.

The cephalothorax is moderately convex, twice as long as broad and one-half of its greatest breadth across the eye-area. The sides of the cephalic part are straight, those of the thoracic

rounded and there are no depressions separating the two; a longitudinal fovea reaches into the rear slope.

The rear row of eyes is slightly recurved and stretches quite across the cephalic part. The median pair are less than one-third of their diameter apart and four times their diameter from the side eyes, which are rather more than half the same diameter across. The front median are one-eighth wider than the rear median, twice their diameter apart, and $2\frac{1}{2}$ times the same from the rear, thus forming a trapezium twice as wide in front as posteriorly and slightly longer than broad. In a lateral direction they are the same distance from the side eyes as from the rear median. The front side eyes are the same size as the rear side, but half their diameter away, and the front and rear are each on a small separate tubercle. The clypeus is $1\frac{1}{2}$ times the width of one of the front median eyes.

The mandibles are conical, kneed at the base, smooth and shiny. There are two teeth on the outer falx-margin, the anterior twice as long as the lower one; three on the inner margin.

The maxillæ are convex and nearly square. The lip has a short, straight-sided base, the longer and very convex upper part curving to an obtusely angled point.

The sternum is slightly convex, twice as long as broad, shield-shaped, hollowed in front, almost straight at the sides, and narrows rather suddenly to a point, which does not go between the contiguous rear coxæ.

The abdomen is oval, $2\frac{1}{2}$ times as long as broad; it is sparsely covered with fine downlying hair and has upstanding spinous bristles on the upper side.

The legs are thin and tapering, rather profusely covered with small brown spots, from which spring long upstanding spines and bristles on the patellar, tibial, and metatarsal joints and under side of femoral. Bristles only on the tarsal joint.

The palpi have the femoral joint incurved, the patella one-half as long as the tibia, and long spinous bristles on the latter.

The measurements (in millimetres) are as follows:—

		Long.	Broad.			
Cephalothorax...		3	{ 1 in front. 1½			
Abdomen.....		5			2	
Mandibles		1¼				
			Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.
Legs	1.	1		3½	4½	4½ = 13½
	2.	¾		3	4	4 = 11¾
	3.	½		2	2¼	1¾ = 6½
	4.	¾		3	3½	3½ = 10¾
Palpi		¼		1	¾	¾ = 2¾

Of *L. Koch's* two species, *L. phthisica* and *L. tabida*, this species more nearly resembles the former, but is two-thirds smaller and much brighter in colouring. The rear median eyes are larger

than the laterals instead of the same size, and the row recurved from above instead of straight; the clypeus broader. The abdomen also is broader in comparison with its length, and there are only two teeth on the outer falx-sheath (one quite long) instead of four small ones. The epigyne also differs from L. Koch's drawing.

The colouring is very close to Dr. Kulczycki's *L. vicina*, from New Guinea, but this species is smaller: the epigyne differs; the rear middle eyes are farther apart; the mandibles longer, two and three teeth respectively, instead of four, on each margin; spots on first pair of legs instead of none; no spots on the back instead of six pairs. The abdomen is also wider in proportion to length.

L. montagui is also very close in most respects to Von Keyserling's *Larinia (Epeira) talipedata*, but in the latter the rear median eyes are as large as the front median, and twice their diameter apart, instead of close together.

This species differs in many points from M. Simon's *L. eburnei-ventris*, from S.W. Australia.

Group ARANEÆ.

Genus ARANEUS Clerck.

ARANEUS REVERSUS, sp. n. (Pl. I. fig. 5.)

This spider belongs to L. Koch's and E. Simon's first series, with shoulder-humps, the abdomen rounded in front and obtusely pointed at the rear.

The cephalothorax, mandibles, and sternum are black-brown with long coarse white hair and white spinous bristles.

The lip and maxillæ are black-brown with wide greyish-yellow margins and red-brown fringes.

The coxæ and femoral joints of the legs and palpi are dark dingy yellow-brown, the patella and tibia nearly black-brown, thickly covered with white hair and numerous spines brown just at the base, but white from there to the point. The metatarsus and tarsus dark dingy yellow-brown with white hair on the basal half of the former, but brown bristles and yellow spines on the anterior half and on the tarsus.

The upper side of the abdomen is at the base yellow mottled with brown spots. Running from this to about halfway down the back is a black-brown median stripe, bordered with yellow and scolloped at the edges into three divisions, and each side of this is a black transverse streak, separated from it by a short longitudinal yellow streak, reaching to the shoulder-humps. From each of these a dark brown scolloped line runs along the side, meeting at the rear end. The latter enclose another scolloped triangular area of brown and yellow intermixed, the straight upper side touching the end of the anterior median stripe. The front part is thickly set with upstanding white spines on brown bases. On the under side a pale

yellow shield pattern, mottled with brown spots, reaches from the genital fold to the spinnerets, with two dark brown longitudinal spots thereon, the basal area being all brown. The spinnerets are black-brown, the epigyne yellow-brown. There is a pair of small brown conical protuberances, one on each side of the breathing-slits. On the sides are vertical black-brown stripes on a dingy yellow ground.

The cephalothorax is one-fifth longer than broad, straight in front, where it is not quite one-half its greatest breadth, convex, rounded at the sides, thickly covered with forward-pointing long coarse hair and upstanding bristles, but bare on the rear slope.

The median quadrangle of eyes is on a somewhat low protuberance lying on the front slope. The rear row is straight, the median their diameter apart, the same distance from the front row, and six diameters from their respective laterals. The front median pair are $1\frac{1}{2}$ times the diameter of the rear and that distance apart. The clypeus is the breadth of one of them. The side eyes are equal in size on a common raised prominence, not much smaller than the rear median, almost touching one another, the front one lying just below and by the distance of its diameter nearer the centre eyes than its upper companion.

The mandibles are broad, conical, kneed at the base, somewhat divergent, and as long as the front of the cephalothorax is broad. They are furnished with bristly hairs for one-third of the distance from the base and on the inner edges, the remainder being smooth. The fangs are stout and not much curved. On the outer margin of the fang-sheath are three stout teeth near the base. I could not see those on the inner margin.

The maxillæ are nearly triangular, straight on the inner side and front edge, with rounded back and corners. They are as high as the greatest breadth, which is at the front margin. The lip is convex, broader than long, rounded in front, and less than half the length of the maxillæ.

The sternum is convex, shield-shaped, rounded at the sides, pointed at the rear, where it does not divide the rear coxæ. There are rounded prominences opposite the 1st, 2nd, and 3rd coxæ. It is thickly covered with long coarse hair and upstanding bristles, particularly thick at the side edges, opposite coxæ 1 and 2.

The abdomen is ovate, rounded in front, obtusely pointed at the rear, thick at the sides. There are two shoulder-humps on the upper side. From between these to the base it is thickly covered with short thick upstanding spines, of which there are also some few in other parts. It is moderately thickly covered with downlying rather coarse hair both on the upper and under side. From the rear end of the upper side to the spinnerets the abdomen sinks perpendicularly a distance equal to the length of the cephalothorax.

The epigyne is of the curious upright pillar type, a stout thick

rounded column rising from an oval muscular scape. The anterior portion is club-shaped seen from behind, but a flattened wedge from the side.

The legs are moderately long and stout, the anterior end of the tibial joints being flattened and broadened out. There are bare streaks on the sides of these, but none above. The thick hair is downlying and smoother than in other parts, and there are no spines above either on these or the patellæ, though several at the sides.

The femoral joint of the palpi is curved inwards, broadest and flattened at the anterior end. The tibial joint is twice as long as the patellar, and numerous upstanding spines and bristles cover the whole length.

The measurements (in millimetres) are as follows:—

		Long.	Broad.			
Cephalothorax...		5	{ $2\frac{1}{4}$ in front. 4			
Abdomen.....		11			9	
Mandibles		$2\frac{1}{4}$				
		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.	
Legs	1.	$1\frac{3}{4}$	6	$6\frac{1}{2}$	6 =	$20\frac{1}{4}$
	2.	$1\frac{3}{4}$	$5\frac{1}{2}$	6	$5\frac{1}{2}$ =	$18\frac{3}{4}$
	3.	$1\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$ =	13
	4.	$1\frac{3}{4}$	$5\frac{1}{2}$	5	5 =	$17\frac{1}{4}$
Palpi		1	2	2	2 =	7

A small non-adult male has the scalloped black stripe at the anterior end of the abdomen and the black scallop bordering the inner pattern at the posterior end, on a yellow-grey ground.

Group GASTERACANTHÆ.

Genus GASTERACANTHA Sund.

GASTERACANTHA MINAX Thor.

10 females and 1 male, P. D. M. 6 females, T. H.

This spider is found in considerable numbers from the east coast of New South Wales, through Victoria and South Australia to the Indian Ocean in Western Australia, its place being taken on the north coast by *Gasteracantha vittata* Thor., which appears by far the most common species there. These specimens are from the most northerly point yet recorded for the species.

GASTERACANTHA MINAX Thor., var. LUGUBRIS L. Koch.

5 females; all black, no bright markings.

GASTERACANTHA MINAX Thor., var. ASTRIGERA L. K.

6 females; black, with orange spot on sternum.

GASTERACANTHA MINAX Thor., var. HERMITIS nov. (Pl. I. fig. 6.)

4 females. Abdomen pearl-grey above, legs, cephalothorax, and sternum bright orange.

I have previously pointed out (Proc. R. S. Vict. vol. xiii. 1900, p. 79) that specimens of L. Koch's species *Gasteracantha astrigera* and *G. lugubris* were generally found wherever there was a number of *G. minax* Thor., and that there was little or no structural difference between the three. I therefore designated the former as varieties only of the latter.

On this small island we find associated with *G. minax* not only these two varieties, but a third, emphasizing the fact that although very different in coloration they are really only varieties, possibly interbreeding, but all essentially the same species.

The shape of the mandibles, mouth-parts, sternum, vulva, and ocelli markings on the back are the same in every case. The spines, however, often vary in length and shape in the same group of similarly coloured specimens.

Family THOMISIDÆ.

Subfamily MISUMENINÆ.

Group DIETÆ.

Genus DIETA E. Sim.

DIETA ISOLATA; sp. n. (Pl. II. fig. 7.)

The cephalothorax is pale canary-yellow, except over the eye-space, which is quite white, with a few scattered fine white hairs.

The mandibles are darker yellow for the basal half, the anterior half bright pale yellow with pink fangs and yellow-grey fringes. The lip and maxillæ pale yellow. Sternum dark grey at the sides with yellow in the middle and pale yellow-grey hair. The legs and palpi are bright yellow, with yellowish-grey spines and a few whitish hairs. The claw-tufts dark grey on the legs and white on the palpi.

The cephalothorax is straight in front and at the sides as far as the back of the eye-space, whence it is almost round, being very slightly longer than broad ($\frac{1}{4}$ mm.). It is slightly convex at the sides, but quite flat in the middle and a little higher before the rear slope, whence it slopes gradually to the front. On the thoracic part are faint broad shallow striations and a similar longitudinal fovea.

The pedicel joining the cephalothorax and the abdomen is inserted into a hollow in the former.

The clypeus slopes forward and is as broad as the median quadrangle of eyes is long. Both rows of eyes are recurved; those of the front row are almost equidistant, the median 4 times their diameter apart. The laterals, whose diameters are $2\frac{1}{2}$ times

those of the median, are so placed that the line touching their lower edges is the breadth of a median eye from the line across the upper edges of the latter.

The median eyes of the rear row are the same size as the front median, $2\frac{1}{2}$ times their diameter apart, 6 of same from the front median and 8 from the laterals, whose diameter is $1\frac{1}{2}$ times that of the former. This row is more recurved than the front, and about 4 times the diameter of the median eyes wider than the front row.

Each eye is on a separate white tubercle, the side ones being much higher than those of the median. The clypeus is as broad as the area of the median quadrangle is long.

The mandibles are short and broad, kneed at the base, thence divergent, the fangs being particularly short and weak.

The lip is straight at the sides, curving to a blunt point anteriorly, longer than broad, and more than half the length of the maxillæ, which are upright, the inner edges parallel and straight; from a rounded fore corner they slope downwards with a straight edge, thence rounded at the back for about halfway, where they curve in for the reception of the base of the palpi.

The sternum is shield-shaped, as broad as it is long, truncate in front, flat in the middle, but sloping off in front and where it narrows at the posterior end.

The abdomen is rounded in front, gradually widening to about one-third of its length from the base whence, to halfway, the sides are straight; from half its length it narrows to the rear end, where it is just the breadth of the space occupied by its spinnerets. The latter are quite terminal, of equal length, and they have a short second joint. The superior are cylindrical, about two-thirds the thickness of the inferior, which are conical, flattened in front. The epigyne is of a horseshoe pattern, inside of which is a long oval longitudinal depression flanked by two shorter oval hollows in the upper half. The base is a transverse semicylinder.

The femoral joint of the legs is moderately stout, but the latter taper considerably and the tarsal joint is very fine. There are claw-tufts of flat bristles and a few scattered hairs on the tarsus and metatarsus. On the under side of the tibia are four pairs, and one odd one, of long spines, and four pairs of similar long spines on the under side of the metatarsus; otherwise the legs are smooth.

The palpi are short, the femoral joint incurved, the patella as long as the tibia, and the distal joint, thickly covered with short bristles, as long as the two preceding.

The measurements (in millimetres) are as follows:—

	Long.	Broad.
Cephalothorax...	$1\frac{3}{4}$	$\left\{ \begin{array}{l} 1 \\ 1\frac{1}{2} \end{array} \right.$ in front.
Abdomen.....	$4\frac{1}{2}$	$1\frac{1}{2}$
Mandibles	6	

		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs	1.	$\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	2	=	$7\frac{1}{2}$
	2.	$\frac{1}{2}$	3	3	2	=	$8\frac{1}{2}$
	3.	$\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	=	$4\frac{3}{4}$
	4.	$\frac{1}{4}$	2	$1\frac{3}{4}$	$1\frac{1}{2}$	=	$5\frac{1}{2}$
Palpi		$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	=	$1\frac{7}{8}$
Patella = tibia.							

This genus has been described from S. Africa, Asia, and Japan, but no species belonging thereto has previously been noted from Australia. This single female specimen apparently conforms to it in every point.

Family CLUBIONIDÆ.

Subfamily LIOCRAINÆ.

Group MITURGÆ.

Genus MITURGA Thor.

MITURGA PARVA, sp. n. (Pl. II. fig. 8.)

One male (T. H.).

Cephalothorax pale yellow-brown in the middle and at the margin, covered with pale yellowish-white hair; between these areas on each side is a longitudinal darker yellow-brown streak, with brown hair, reaching from the eye-space to the rear. At the margin there are also darker spots, and a thick fillet of yellowish-white hair projecting from the edge outwards.

The mandibles are dark yellow-brown for two-thirds of the length from the base, paler anteriorly, with dingy yellowish-white hair. The fangs are bright yellow-brown.

The lip, maxillæ, and sternum are pale yellow with similar yellowish-white hair rather darker on the fringes.

The abdomen above is yellow-brown, with pale yellow-brown hair. On each side, reaching from the base to halfway, is a brown streak and between these, two narrower, less distinct, streaks, and brown blotches between the end of the side stripes and the spinnerets. At the base are a number of brown bristles. The under side is similarly coloured at the base and sides. Beginning at the genital fovea and reaching nearly to the spinnerets is a wedge-shaped area of black hair broadest anteriorly. On this are two longitudinal rows of large white spots, and on each side a clear white streak bounds the black area. The legs and palpi are dark yellow on the basal part of the femoral joint, getting paler towards the anterior joints, with yellowish-white hair, nearly white scopulæ and claw-tufts, and yellowish-grey spines.

The cephalothorax is ovate, one-fourth longer than broad, convex, thickly covered with coarse downlying hair. Round the outer edge of the thoracic part is a thick fillet of hair extending beyond the margin. There is a long broad longitudinal fovea reaching to the rear slope.

The rear row of eyes is recurved; the median eyes one-third of their diameter apart and their diameter from the side eyes, which are on low tubercles and just slightly smaller.

The front row is straight viewed from in front, slightly recurved from above, all the eyes equal in size to the rear laterals and their diameter distant from the rear median. The median are one-third their diameter apart and half that distance from the laterals. The clypeus is not quite twice their diameter in width.

The mandibles are strong and convex, with long powerful falces and two separated teeth on the inner margin of the falx-sheath.

The lip is broader than long, straight in front, widening to the base, and less than half the length of the maxillæ. The latter are convex, straight on the inner side and at the apex, but rounded at the corners and on the outer side.

The sternum is a broad oval, hollowed opposite the coxæ, and ending in a small point posteriorly well above the contiguous rear coxæ. It is thickly covered with coarse downlying hair in the middle, upstanding round the margin.

The abdomen is oval, twice as long as broad. The spinnerets are terminal, with thick matted hair on the upper side, smoother below. In the superior pair the conical second joint is two-thirds as long as the basal.

The legs are thickly covered with long coarse hair, with numerous short and some long powerful spines on the femora, tibiæ, and metatarsi. There are two spines above on tibia iv. On the under side of tibia i. and ii. are three pairs of spines; also three spines on the inner side of tibia ii., two on tibia i. The claws are short and weak. There are thick scopulæ on all tarsi and metatarsi.

The palpi have the femoral joint incurved, thinner than the other joints, but broadest anteriorly. The patellar joint is shorter and narrower than the tibial, which widens out in front with an apophysis having a curved cusp on the outer corner, but square on the inner.

The measurements (in millimetres) are as follows:—

	Long.	Broad.
Cephalothorax...	5	$\left\{ \begin{array}{l} 2\frac{1}{4} \text{ in front.} \\ 4 \end{array} \right.$
Abdomen.....	6	3
Mandibles	$2\frac{1}{4}$	

		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs	1.	$1\frac{1}{2}$	$5\frac{1}{2}$	6	$5\frac{1}{2}$	=	$18\frac{1}{2}$
	2.	$1\frac{1}{2}$	$5\frac{1}{2}$	6	$5\frac{1}{2}$	=	$18\frac{1}{2}$
	3.	$1\frac{1}{2}$	$4\frac{1}{2}$	5	5	=	16
	4.	$1\frac{1}{2}$	6	7	7	=	$21\frac{1}{2}$
Palpi		1	$2\frac{1}{2}$	2	$1\frac{1}{2}$	=	7

This differs from *M. lineata* Thor., *M. gilva* L. K., *M. agelina* E. S., *M. occidentalis* E. S., *M. severa* E. S., *M. ferina* E. S., besides other points, in having a black area with white longitudinal lines on the under side of the abdomen, and having darker spots but no continuous line along the margin of the cephalic part of the cephalothorax.

From *M. thorelli* E. Sim., in having the front median eyes smaller than the rear median and one cusp only instead of two on the tibial apophysis of the male palp.

From *M. maculata* H. R. H., *M. whistleri* E. Sim., *M. impedita* E. Sim., and *M. catagrapta* E. Sim., besides numerous points which will be gathered from the descriptions, in having three spines on the inner side of tibia ii. and two spines on the inner side of tibia i.

Subfamily SPARASSINÆ.

Group DELENEÆ.

Genus OLIOS Walck.

OLIOS CALLIGASTER Thor.

3 females (T. H.) non-adult.

1 female (P. D. M.) non-adult.

These specimens, despite the fact that none of them is fully developed, are all larger than those measured by Thorell and L. Koch from the eastern and southern parts of the Continent. In other particulars they quite agree with the original descriptions.

The under side of all the patellæ and tibiæ is marked with alternate stripes of brilliant silver-grey and brown instead of partly yellow, possibly because they are younger.

The measurements (in millimetres) are as follows:—

		Long.	Broad.				
Cephalothorax...		9	$\left\{ \begin{array}{l} 6 \text{ in front.} \\ 7 \end{array} \right.$				
Abdomen.....		14	9				
Mandibles		$4\frac{1}{2}$					
		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs	1.	$3\frac{1}{2}$	$9\frac{1}{2}$	10	$9\frac{1}{2}$	=	$32\frac{1}{2}$
	2.	$3\frac{1}{2}$	10	$10\frac{1}{2}$	10	=	34
	3.	3	$7\frac{1}{2}$	$8\frac{1}{2}$	$7\frac{1}{2}$	=	$26\frac{1}{2}$
	4.	$3\frac{1}{2}$	$8\frac{1}{2}$	9	$8\frac{1}{2}$	=	$29\frac{1}{2}$
Palpi		$1\frac{1}{2}$	4	3	3	=	$11\frac{1}{2}$

OLIOS HERMITIS, sp. n. (Pl. II. fig. 9.)

1 female (P. D. M.) non-adult.

2 females (T. H.) (1 ceph. only).

These specimens, none of which is quite adult, are very close to L. Koch's *Olios* (*Savotes*) *procerus* from the east coast. They differ, however, in the front median eyes being smaller instead of larger than the rear median. The clypeus is as wide as the distance between the front and rear median eyes—plus the diameter of a front median. The lip is less than half the length of the maxillæ instead of half as long, and the legs are more equal in length, the fourth pair being equal to the front pair, and the second only slightly longer. It is therefore worthy of being made a new species.

The cephalothorax is yellow-brown, with a rather broken yellow-brown marginal stripe on the thoracic part, a similar horseshoe pattern of large brown spots nearer the centre with a single spot between the forward pointing open ends. The eyespace is black-brown, and there are two fainter brown spots behind the rear row. The hair is fine and silvery white, but brown on the spots. The mandibles are yellow with a brown stripe on the outer edge reaching rather more than halfway from the base, and the fangs are brown. On the inner edge of the falx-sheath are three large teeth followed by one small one; on the outer margin one large between two small. The lip, maxillæ, and sternum are darker yellow with brown bristly hair.

The legs are orange, with three brown rings on the femur, 1 on the patella, 2 on the tibia, and 2 on the metatarsus of each leg. The scopula on the metatarsus and tarsus are grey, and the claw-tufts nearly black. There are two very long spines, one in front of the other, on the under side of the tibial joint. The tarsal claws are long, with about 10 pectinations on a straight shaft bent at the anterior end, and the female palp-claw has about half that number.

The measurements (in millimetres) of the largest (front pair of legs only) and of a smaller whole one, are as follows:—

	Long.	Broad.				
Cephalothorax...	6	{ 3 in front. 5½				
Abdomen.....	8					
Mandibles	3					
	Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs 1.	2	9½	11½	9½	=	32½
Palpi.....	1	3½	3½	3½	=	11½
	Long.	Broad.				
Cephalothorax...	4½	{ 2 in front. 4				
Abdomen.....	5					
Mandibles	2	3½				

		Coxæ.	Tr. & fem.	Pat. & tib.	Metal. & tars.		
Legs	1.	$1\frac{1}{2}$	7	8	7	=	$23\frac{1}{2}$
	2.	$1\frac{1}{2}$	7	$8\frac{1}{2}$	7	=	24
	3.	$1\frac{1}{4}$	6	7	6	=	$20\frac{1}{4}$
	4.	$1\frac{1}{2}$	7	8	7	=	$23\frac{1}{2}$
Palpi.....		$\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$	2	=	$7\frac{3}{4}$

There are two quite young specimens having the front row of eyes straight and of equal diameter—the median pair being their diameter apart, but only half that distance from the laterals. Sternum yellow.

They do not seem to agree with any described species, but are too young to found one on.

Another still smaller seems to be the same, but the front median eyes are apparently farther apart in comparison with their diameter, and one-half that distance from their laterals.

Subfamily MICARIINÆ.

Group MICARIÆ.

Genus MONTEBELLO, gen. nov.

This differs from *Pœcilipta* Sim. in having the cephalothorax only slightly less broad posteriorly than in its widest part between the 2nd and 3rd coxæ, whence it narrows to the front, which is truncate. The clypeus distinctly narrower than the front median eyes. The abdomen tapering posteriorly. The area of the median eyes broader than long; the front median larger than the others; the rear row straight or slightly procurved. The 4th pair of legs only moderately longer than the others.

M. TENUIS, sp. n. (Pl. II. fig. 10.)

The cephalothorax is pale yellow-brown with a metallic sheen. The mandibles greyish yellow on the basal half, yellower on the anterior, fangs yellow. Lip, maxillæ, and sternum greyish yellow with grey fringes on the former and pale grey hair on the latter. The legs and palpi are pale yellow with almost white hairs, grey spines, and dark grey claw-tufts. The abdomen is pale yellow on the upper side with short fine dark, and some lighter grey hairs, and a darker median longitudinal stripe on the posterior half; on the under side it is pale yellow all over.

The cephalothorax is truncate in front, longer than broad, rounded at the rear, only slightly narrowing posteriorly from its widest point between the 2nd and 3rd coxæ. From this point it also narrows anteriorly, where it is $\frac{2}{5}$ of its greatest breadth. It is convex, sloping rather steeply to the edge in the cephalic part, and to a flat marginal area at the sides of the cephalic. There is a short thin longitudinal fovea at the top of the rear slope. There are no radial markings, the surface being quite smooth and only a few hairs at the rear of the eye-space.

The rear row of eyes is slightly procurved, equal in diameter, the median being three diameters apart and two of the same from the laterals, and the same distance from the front median. The

median-eye areas broader than long. The front eyes, $1\frac{1}{2}$ times the diameter of the rear, are the diameter of the latter apart; they are the same distance from the front laterals, the row being nearly straight. The front and rear laterals are of equal diameter, $1\frac{1}{2}$ of that distance apart. The rear median eyes are sessile, all the laterals on slight protuberances and the front median still more protuberant. The clypeus is only half as broad as a front median eye.

The mandibles are straight on the outer side, slightly kneed at the base, and as long at the front of the cephalothorax as broad, only diverging from each other anteriorly to the extent of the slope of the falx-sheath. The fangs are moderately curved, slight and fairly long; on the inner margin of the sheath are two equal-sized teeth, and on the outer, one equally long between two smaller. The lip is broader than long, rounded anteriorly, straight at the sides but narrowing slightly to the base, with the anterior margin protuberant. It is not more than one-third the length of the maxillæ. The latter are straight at the anterior margin, nearly parallel at the inner and outer sides, but just rounded at the front corners and widening near the base at the insertion of the palpi.

The sternum is oval, twice as long as broad, narrowing to a point at each end. It is convex with deep depressions in the margin between each pair of coxæ: the rear pair of the latter are contiguous and longer than the rest.

The abdomen is not quite twice as long as broad; it is rounded in front, but not scutate, widest about the genital fold, whence it narrows evenly to the spinnerets, which are quite terminal and of equal length, the inferior pair contiguous, conical, with quite short hemispherical second joint, the superior cylindrical with a similar short rounded second joint. There are no plumose hairs.

The legs are short and slender, the tarsal joints flat, the two claws have 7 or 8 pectinations, a few long spines and bristly upstanding hairs on the tibial and metatarsal joints, and claw-tufts of spatulate bristles.

The palpi are inserted at the lower end of the maxillæ, the femoral joint incurved and broadened at anterior end.

The measurements (in millimetres) are as follows:—

		Long.	Broad.			
Cephalothorax...		$2\frac{1}{2}$	{ 1 in front. 1 $\frac{1}{2}$			
Abdomen.....		$3\frac{1}{2}$	2			
Mandibles		1				
		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.	
Legs	1.	$\frac{1}{2}$	$1\frac{1}{2}$	2	$1\frac{1}{4}$	= $5\frac{1}{4}$
	2.	$\frac{1}{2}$	$1\frac{1}{2}$	2	$1\frac{1}{4}$	= $5\frac{3}{4}$
	3.	$\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{2}$	= $4\frac{3}{4}$
	4.	$\frac{3}{4}$	2	2	2	= $6\frac{3}{4}$
Palpi		$\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	= 2

There is one female specimen only (P. D. M.), and the epigyne is not clear enough to draw.

Family LYCOSIDÆ.

Group LYCOSEÆ.

Genus LYCOSA Latr.

LYCOSA CLARA L. Koch.

A number of females, only one apparently adult, although they are mostly larger than L. Koch's specimens.

The epigyne is more like L. Koch's drawing of that of *L. crispipes*, but it otherwise differs from the latter in too many points to be confused with it, and agrees in all others with *L. clara*. Moreover, the epigyne of the two forms are not very dissimilar with the exception of the ogee-shaped anterior curve of the latter, which is so unusual as to suggest that there may have been some distortion in the specimen from which L. Koch's drawing was made.

The measurements of the largest (in millimetres) are as follows:—

	Long.	Broad.
Cephalothorax...	10	$\left\{ \begin{array}{l} 3 \text{ in front.} \\ 4 \text{ below.} \end{array} \right.$
Abdomen.....	9	7 between 2 and 3 pairs of coxæ.

		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs	1.	3	9	$9\frac{1}{2}$	10	=	$31\frac{1}{2}$
	2.	3	9	$8\frac{1}{2}$	$9\frac{1}{2}$	=	30
	3.	3	$8\frac{1}{2}$	$8\frac{1}{2}$	10	=	30
	4.	3	10	10	12	=	35
Palpi		$1\frac{1}{2}$	4	$2-2\frac{1}{2}$	$2\frac{1}{2}$	=	$12\frac{1}{2}$

Family OXYOPIDÆ.

Genus OXYOPES Latr.

OXYOPES ? MUNDULUS L. K.

Four females, of which one only is adult. The eye-plan is the same in all, and they have numerous flat hairs on the under side of the abdomen, but the younger are all darker in colouring and might be different.

They are rather close to several of L. Koch's species, which are not easy to distinguish. In pattern and size they seem nearest to *O. mundulus*, *O. amœnus* L. K., and *O. variabilis* L. K., to all of which the epigyne might conform.

The measurements (in millimetres) are as follows:—

	Long.	Broad.
Cephalothorax...	3	$\left\{ \begin{array}{l} 1\frac{1}{2} \text{ in front.} \\ 2 \end{array} \right.$
Abdomen.....	6	3
Mandibles	$1\frac{1}{4}$	

		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs	1.	$\frac{3}{4}$	4	$3\frac{1}{2}$	4	=	$12\frac{1}{4}$
	2.	$\frac{3}{4}$	$3\frac{1}{2}$	$3\frac{1}{2}$	4	=	$11\frac{3}{4}$
	3.	$\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	=	$8\frac{1}{4}$
	4.	$\frac{3}{4}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$5\frac{1}{2}$	=	$13\frac{1}{4}$
Palpi		$\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	1	=	4

Genus PEUCETIA Thor.

PEUCETIA MARGARITATA, sp. n. (Pl. II. fig. 11.)

The cephalothorax is pale yellow mottled with white and brown upstanding bristles. The eye-space is black and dark yellow-brown, with white downlying flat lanceolate hairs. Mandibles, lip, maxillæ, and sternum bright yellow, fangs of former darker orange. The legs are bright yellow on all joints, with long grey spines and upstanding brown bristles on brown roots. There are short, fine, white scattered hairs on the femoral joints, short brown hairs on the others.

The cephalothorax is longer than broad, rounded at the sides and rear, narrowed in front. It slopes gradually from the sides of the thoracic part, but steeply from the cephalic, with a nearly perpendicular clypeus three-quarters the length of the eye-space.

The cephalic part is clearly separated by depressions from the thoracic part, and there is a deep longitudinal fovea on the rear slope. On the median line are three pairs of bristles with circular roots.

The rear row of eyes is procurved, so that the uppermost points of the laterals are on a line with the lowest part of the median. They are equidistant, but the median are quite perceptibly larger than the laterals, and their distance apart is rather more than the diameter of the former.

The eyes of the second row (the laterals of the front row) are the largest and most prominent of any, their diameter being equal to that of the rear median and a front row combined. They are this distance from the rear laterals. The front row (or front median) are two-fifths the diameter of their laterals (2nd row), their diameter apart, and the same distance from their laterals. The clypeus is the length of the quadrilateral formed by the rear median and 2nd row of eyes.

The mandibles are as long as the cephalothorax is broad in front, conical and slightly kneed at the base, with scattered upstanding bristles on the front and hair on the inner and outer sides. The fangs are broad at the base, but short and weak. The margin of the falx-sheath is smooth but with a fringe on the outer margin.

The maxillæ are long and narrow, rounded anteriorly, and parallel at the side, bending forward over the lip, which is twice as long as it is wide halfway up, but broadens out at the base; it is rounded anteriorly and more than half the length of the maxillæ.

The sternum is shield-shaped, straight in front, rounded at the rear, where it is nearly as broad as in front, the rear coxæ being $\frac{3}{4}$ of their width apart.

The legs are long and fine, tapering anteriorly. They are only sparsely furnished with short downlying hairs on the femoral joints, and short bristly upstanding ones on the other joints. There are five or six pectinations on the superior tarsal claws. There are three pairs of long spines on the under side of all tibiæ, two pairs underneath the metatarsi and about five shorter at the anterior end of same.

The abdomen is broken in each specimen, but in one of them the epigyne is intact; it is roughly similar to, but more elaborated than that shown in L. Koch's drawing of the only species previously recorded from Australia.

The measurements (in millimetres) are as follows:—

	Long.	Broad.					
Cephalothorax...	3	{ $1\frac{1}{2}$ in front. $2\frac{1}{2}$					
Mandibles	$1\frac{1}{2}$						
		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.		
Legs	1.	$\frac{3}{4}$	5	$4\frac{1}{2}$	5	=	$15\frac{1}{4}$
	2.	$\frac{3}{4}$	4	4	4	=	$12\frac{3}{4}$
	3.	$\frac{1}{2}$	$3\frac{1}{2}$	3	$3\frac{1}{2}$	=	$10\frac{1}{2}$
	4.	$\frac{3}{4}$	4	3	4	=	$11\frac{3}{4}$
Palpi		$\frac{1}{4}$	$1\frac{1}{4}$	1	$\frac{3}{4}$	=	$3\frac{1}{4}$

Two females sent by Mr. Haynes.

These would seem to differ from *P. albescens* L. K. in the lighter and brighter colouring, in having no row of dark spots on the side slopes of the cephalothorax, in the greater length of the legs compared with the cephalothorax (4 to $3\frac{1}{4}$), and the clypeus not so long as the eye-space, and the more defined epigyne.

Family ATTIDÆ.

Group MARPISSÆ.

Genus MARPISSA C. Koch.

MARPISSA RIDENS, sp. n. (Pl. II. fig. 12.)

The cephalothorax is black-brown on the cephalic part, dark yellow-brown on the thoracic. On the former and on a marginal stripe are downlying white hairs interspersed with orange. The side slopes and posterior end are bare; on the clypeus is a fringe of coarse orange-coloured hair.

The mandibles are black-brown with a few brown bristles on the basal half. The fangs are dark yellow-brown.

The lip and maxillæ yellow-brown, paler at the margins, with dark grey fringes and brown upstanding hairs.

The sternum dark yellow-brown with white hairs.

The abdomen on the upper side has a broad median area from base to spinnerets of coarse white hair interspersed with orange and upstanding brown bristles; on each side of this is a longitudinal stripe of black hair reaching the whole length. The sides and under side are yellowish white. The spinnerets and epigyne are dingy yellow-brown, with bright yellow inside the chitinous ring of the latter.

The legs are pale yellow with white hair, brown spines, and dark grey claw-tufts. The palpi are thickly covered with long white upstanding hair.

The cephalothorax is nearly $1\frac{1}{2}$ times as long as it is broad, straight in front, rounded at the rear, slightly narrowing from about the middle to the front row of eyes. The cephalic part is flat above, sloping slightly to the sides, as does also the thoracic part, which is rather more convex, but has a broad shallow transverse depression at its anterior end.

The eye-space is broader than long, the rear row being narrower by almost one-fourth than the cephalothorax at that point. The small eyes of the second row are rather nearer to those of the rear row than to the front laterals, and lie in a line between their centres.

The front row is slightly recurved, the median eyes being close together; the laterals, half their diameter, are clearly separated from them and lie rather farther back. The clypeus is half the breadth of the front median eyes.

The mandibles are short, flat and rather divergent, with moderately long tapering fangs. There is one tooth, strong and conical, on the inner margin of the falx-sheath, and two smaller near together on the outer.

The maxillæ are upright, rounded anteriorly and at the outer margin.

The lip, longer than broad, is more than half the length of the maxillæ. It curves inwards from near the front, but is nearly straight at the end. The front pair of coxæ almost meet at their bases, and with their trochanters cover the lower part of the lip and maxillæ.

The sternum narrows to a point between the front pair of coxæ, broadens to its greatest width above coxæ iii., and ends in front of the fourth pair, which are close together.

The front two pairs of coxæ are parallel, pointing forwards at an angle of 45 degrees from the median line, the rear two pairs similarly pointing backwards at right angles to the front pairs, the 2nd and 3rd being slightly separated. The rear coxæ are longer than the others, which are all about the same length.

The front pair of legs are stouter than the others, the femur being flat and club-shaped. The patella and tibia are longer than the metatarsus and tarsus in all legs, the latter joint shorter than the metatarsus.

On the under side of tibia i. and ii. are three pairs of short

spines, under metatarsus i. and ii. two similar pairs. On tibia iii. and iv. is a single pair, and a bunch at the end of the metatarsus of same. The femoral joint of the palpi is incurved and broadest at the anterior end, the tibia longer than the patella.

The abdomen is rather longer than the cephalothorax, truncate in front, straight at the sides for $\frac{2}{3}$ of its length, whence it narrows to an obtuse point; the epigyne is a chitinous oval ring thickest at the posterior end, granular inside, with two small club-shaped protuberances therein near the lower end.

The measurements (in millimetres) are as follows:—

		Long.	Broad.						
Cephalothorax...		3.1	{ 1.6 in front.						
			{ 2.2						
Abdomen		3.5	1.5						
Mandibles		$\frac{3}{4}$							
		Coxæ.	Tr. & fem.	Pat. & tib.	Metat. & tars.				
Legs	1.	$\frac{3}{8}$	$1\frac{1}{2}$	2	$1\frac{1}{2}$	=		$5\frac{1}{8}$	
	2.	$\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{1}{4}$	=		$4\frac{7}{8}$	
	3.	$\frac{3}{8}$	1.6	2	$1\frac{1}{2}$	=		$5\frac{1}{2}$	
	4.	$\frac{1}{2}$	2.2	2.3	2	=		7	
Palpi		$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	=		$1\frac{7}{8}$	

This may be distinguished from any of the recorded Australian species by the black lines on the back of the abdomen and the pattern of the epigyne.

Another smaller specimen, apparently of the genus *Marpissa*, has contiguous front coxæ longer than the rest, weaker mandibles, and tarsus i. as long as the metatarsus, but is too broken to describe.

EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Tetragnatha angulata*, sp. n. ($\times 2$). a. Mandible from outer side. b. Mandible from inner side. c. Epigyne.
 2. *Nephila meridionalis* Hogg, var. *hermitis*, nov. (nat. size). a. Underside of abdomen. b. Profile. c. Eyes.
 3. *Argiope haynesi*, sp. n. (nat. size). a. Underside of abdomen ($\times 2$). b. Epigyne. c. Eyes.
 4. *Larinia montagui*, sp. n. ($\times 2$). a. Eyes. b. Epigyne.
 5. *Araneus reversus*, sp. n. (nat. size). a. Male (non adult), $\times 2$. b. Eyes of female. c. Epigyne. d. Epigyne from side.
 6. *Gasteracantha minax* Thor., var. *hermitis*, nov. a. Epigyne.

PLATE II.

- Fig. 7. *Dieta isolata*, sp. n. ($\times 2$). a. Eyes and mandibles. b. Epigyne.
 8. *Miturga parva*, sp. n. (nat. size). a. Eyes. b. Underside of abdomen ($\times 2$). c. Male palp.
 9. *Olios hermitis*, sp. n. (nat. size of immature). a. Eyes. b. Lip and maxillæ.
 10. *Montebello tenuis*, gen. et sp. n. ($\times 2$). a. Eyes. b. Mandibles. c. Lip, maxillæ, and sternum.
 11. *Peuceetia margaritata*, sp. n. ($\times 2$). a. Eyes. b. Epigyne.
 12. *Marpissa rideus*, sp. n. ($\times 2$). a. Eyes. b. Epigyne. c. Lip, maxillæ, left mandible, and first pair of coxæ.

7. On the Nests of Pseudoscorpiones: with historical notes on the Spinning-Organs and observations on the Building and Spinning of the Nests. By H. WALLIS KEW, F.Z.S.

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I.

The False-Scorpions' ability to spin was denied by some of the older writers, *e. g.* by Frisch (1), and doubted by others, *e. g.* De Théis (4), but it is now known that they construct nests in part or wholly of silk from their own bodies. Balzan (15) named a species *Chelifer nidificator*; but the nests are not peculiar to particular species or groups. They are known for *Chelifer*, *Cheiridium*, *Garypus*, *Garypinus*, *Olpium*, *Obisium*, and *Chthonius*: genera which represent both main divisions of the Order—Panctenodactyli and Hemictenodactyli—and the four main families—Cheliferidæ, Garypidæ, Obisiidæ, and Chthoniidæ; and it is thus probable that these structures are common to all Pseudoscorpiones*.

The purposes for which the nests are made are known—at least satisfactory statements on this head exist—and the nests themselves, which have often a more or less elaborate covering of extraneous matters, have been described with more or less detail and accuracy by several writers. When one enquires how they are made, however, no answer is forthcoming. The manner in which the extraneous matters are collected and arranged is unknown; and as regards the spun-tissue, the position of the silk-glands and external spinning-organs was long mis-stated; and the subject is still surrounded with uncertainty. With the exception of a statement by Menge (6), which has proved to be mistaken, no description of the animals' methods is known; and it does not appear that the drawing out of the silk has ever been witnessed.

It is proposed here to give a brief re-statement of the subject, and to record some direct observations.

* The construction of nests is the only use the animals are known to make of their spinning. They have been said, by this means, "to envelop the eggs in a cocoon" (17). But no False-Scorpion covers its eggs with silk; and since the eggs are not laid, the egg- and brood-pouch remaining attached to the mother, the thing is impossible.

II.

As already stated, the purposes for which the nests are made are known; but they are inadequately stated in most of the books. The animals thus enclose themselves for moulting, for brood-purposes, and also in some cases for hibernation. Nests for moulting are probably universal and made by all individuals of both sexes. They protect the animal during ecdysis and the periods of helplessness which precede and follow it. Those for brood-purposes, made by females, are probably universal in that sex; but in exceptional cases they are slight and easily overlooked. They protect the distended animal and attached egg- and brood-pouch, and also the young, which remain for a time enclosed with the mother*. Nests for hibernation are probably less general. It is certainly true of some species, perhaps of many, that most individuals of both sexes rest in nests during winter. In these they are protected no doubt from cold; and perhaps also from moisture, which might freeze around them with harmful results.

III.

References to the nests in published papers, and my own notes on the subject, are too numerous to be collected here. It may be permissible, however, to pass in review the main groups and to refer more particularly to a small number of species. Godfrey (29, 36) is the author who more than anyone else has attended to these structures.

Of the families of Panctenodactyli—Cheliferidæ, Feaellidæ, and Garypidæ—the last two are foreign to our fauna and their nests are unknown to me. Those of Feaellidæ do not appear to have been observed. It is otherwise with Garypidæ. Lucas, in 1849 (5), wrote of *Olpium pallipes* Luc., that it lives under or in the crevices of stones where it constructs “une petite coque sans issue, d’un tissu soyeux, serré, revêtue à l’extérieur de grains de sable et de parcelles de terre.” *Garypinus capensis* Ell. is stated by Godfrey (36) to make nests, between flakes of bark of trees, “of silk only without any covering of dust or specks of wood.” According to Becker (10) the nest of the large *Garypus* of the Mediterranean—*Garypus litoralis* L. Koch of this author—is “une coque de soie hermétiquement fermée.” He refers also to similar silken nests of *Garypus minor* L. Koch. These last are more particularly described by Barrois (22), who found them

* Bouvier (21), writing of the nests of the large *Garypus* of the Mediterranean, has indicated that they contained brood-pouches developing in the absence of the mother; and some prominence has been given to this statement by With (27). Further observations, however, convinced Bouvier that he was mistaken; the mother had doubtless escaped, leaving the brood-pouch behind, subsequently to the collection of the nests. It is possible, however, that some species, e.g. *Cheiridium museorum* Leach, may cast off the brood-pouch and leave it in the nest after the larvæ have ceased to suck; cf. Godfrey (29). To recur to the *Garypus*, Becker (10) tells us that he found “les deux sexes réunis dans une coque de soie”; an observation which stands alone and deserves investigation.

on the shore at Villefranche attached to the under-surface of stones: "Chaque loge se compose d'une espèce de petite capsule de forme arrondie tapissée intérieurement par un feutrage blanc auquel adhèrent extérieurement de menues parcelles de terre ou de débris végétaux." He adds that they were completely closed, the animal apparently remaining imprisoned all the winter*. In Cheliferidæ the nests have frequently been mentioned, and I have had opportunities of examining those of several species. The earliest reference for "*Chelifer*" is that of Hermann, 1804 (3), who mentions the occurrence of one of these animals "dans un follicule soyeux, enduit de poussière et attaché à une paroi par un de ses côtés." Of the four sub-genera of *Chelifer*, there is a mention of nests of *Withius* by Godfrey (36), who refers without particulars to those of *C. simoni* Balz. In *Atemnus*, the same author found *C. feae* Ell. "in a very roomy nest on a gum-tree"; and to this sub-genus belongs Balzan's *C. nidificator* (15), found under flakes of a tree-trunk, in "nidi, in forma di cellule contigue, di una sostanza cerosa, biancastra, simile alla seta di certi ragni." In *Chelifer* s. s. and *Chernes*, I will refer to two species of the former *C. cancroides* Lin. and *C. latreillii* Leach, and to two of the latter *C. cyrneus* L. Koch and *C. cimicoides* Fabr.†. *C. cancroides* Lin., which is well-established but doubtfully indigenous with us, lives in stables and such-like places. Godfrey (29) found its nests in a loft in Glasgow in narrow crevices in old harness. He describes them as "closed elliptical rings of dust particles, within which was the inner silken lining appressed throughout the extent of both upper and lower surfaces against the leather." They belonged evidently to immature individuals, and some of them contained cast-skins. A few years ago I examined a colony of this animal in stables at Grays. Between the double boards of the stall-partitions were spaces separated into compartments by the uprights and completely closed in; and on some of these boards being removed many nests were found on their inner surfaces. These spaces of course were much too wide to admit of the nests being attached both above and below; and, as is usual in such cases, the tissue of the floor only was attached to the wood and was continued above as a free convex roof. They bore externally a partial covering of extraneous fragments. Most of them were inhabited; and in at least two were found females with the brood-pouch attached. *C. latreillii* Leach is a maritime species with us, occurring along our eastern shores. On those of Fife-shire and East Lothian it is found in rock-crevices; and Godfrey (29) states that its nests, used for moulting and also, he believed, for hibernation, are large and made generally

* The quotation is from Dr. Barrois' well-known "Mémoire sur le développement des *Chelifer*," the subject of which was in reality *Garypus minor* L. Koch. I am indebted to the author for specimens of the animals and to M. Simon for obligingly examining them.

† For the nomenclature of British and Irish species referred to in this paper, cf. Kew (33).

between two closely placed pieces of rock; they are formed, he says, of earth with a silk lining and with a silken floor and roof attached to the rock. In several English counties the animal inhabits the sand-dunes of the coast; and under these conditions I have often observed it, especially in Lincolnshire, where it is abundant on the fine range of dunes which extends from the Humber to the Wash. In such places it makes its nests for the most part in old sheathing-bases of marram-grass (*Ammophila arenaria*) and sometimes under bark of maimed stumps of *Hippophaë rhamnoides* and *Sambucus nigra*. Those made for brood-purposes are frequently slight in texture, the animal being distinctly visible within. Of nests for hibernation I am not able to say anything not having observed the animal in winter. The moulting-nests, however, are of the usual dense tissue; and when in relatively wide spaces they have usually a free roof. In such cases and whenever there is any considerable expanse of free tissue there is usually a regular covering of grains of sand. *C. cyrneus* L. Koch and *C. cimicoides* Fabr. are forest species found under rather close-fitting bark of dead or partly dead standing trees. I have already given notes of the nests of the former observed in Sherwood Forest (26), and more recently have had many opportunities of observing them in Richmond Park*. The brood- and winter-nests are surprisingly large, even for this large species, having frequently a diameter of 10 mm. They are built usually in narrow crevices, and thus they do not as a rule exhibit a free roof. This feature is commonly seen, however, in the smaller moulting-nests. The free membrane has usually a covering of woody fragments, which is often dense and beautifully regular. The nests of *C. cimicoides*—smaller in accordance with the smaller size of the animal—have been observed by me in many places, and particularly in Epping Forest, where they are readily found under the bark of the old pollards. The brood-nests are apt to be slight and informal in this species; but the moulting- and winter-nests are ordinarily stout and often exhibit a free roof; and they are remarkable for the density and regularity of the almost invariably complete covering of woody fragments. To the same family belongs *Cheiridium*, whose nests are unusually small and flat. *Cheiridium museorum* Leach occurs, e.g., behind the boards of old barns where the nests are often crowded together in great numbers. They have a diameter of about 2 mm.; and the roof, which is very slightly convex, has a close covering of minute miscellaneous objects. The nests of *Cheiridium ferum* Sim. are still smaller and scarcely, if at all, convex; they are pearly white and quite destitute of attached particles. This at least was the condition of a number sent to me by Godfrey, who found them under flakes of pine-bark in Brittany. Subsequently (36) he

* I am indebted to His Majesty's Office of Works, and to Mr. S. Pullman, the Superintendent of the Park, for the permission and facilities necessary for observing and collecting in this place.

found the same animal in South Africa with many nests under bark of gum-trees. The structures were similar to those above mentioned, of white silk only, and very conspicuous.

In Hemictenodactyli—families Obisiidæ and Chthoniidæ—the nests of both *Obisium* and *Chthonius* are known. The first note for *Obisium* is by Menge, 1855 (6), who found a brood of young “mit der alten Mutter in einem halbrunden Gespinnst zwischen zwei Blättern.” Löw (7) records a female with brood-pouch in a snail-shell; of which the mouth “mit einem dichten, weissen, homogenen Spinnengewebe völlig verschlossen war.” According to Simon (9), *O. jugorum* L. Koch in the frozen regions of the Alps constructs a nest “presque arrondie et sans ouverture, dont le tissu agglutinant se recouvre de terre et de brindilles végétales.” The common *O. muscorum* Leach was observed in detail in Scotland by Godfrey (29). The favourite site for its nest is the under-surface of a stone, but other situations such as the face of a rock covered with herbage or a bed of moss on a tree-stump may be selected. The structure is usually strongly domed. It consists externally of earth, earth and sand, or earth and rotten wood, and internally has a close firm lining of silk, which is continuous, as usual, not only over the interior of the built parts but also over the enclosed surface of the object to which the nest is attached. In the south-west of Ireland there is a larger species, *O. carpenteri* Kew (32), whose nests I found abundantly under loose flakes of ragged outer-bark of *Arbutus unedo*. They are larger than those of *O. muscorum*, and differ in having no regular covering of earthy or woody fragments. The dense white spun-tissue of the nest is in fact usually quite free from extraneous particles. Both moulting- and brood-nests occurred on the trees; and in addition, many of the former were found in rock crevices. *O. maritimum* Leach, another large species, lives below high water-mark on the sea-shore, where it occurs in deep-seated rock-crevices and under large embedded stones. Its nests—first mentioned by Ferrounière (24)—have been observed by Godfrey in Scotland (29), by Jackson in the Isle of Man (28), and by me in Devon and Cornwall and in Ireland (32, 34). They occur in the situations just indicated and, as in the case of *O. carpenteri*, the dense white spun-tissue has no coating of extraneous matters. Spun amidst surroundings constantly moist, they are stout and tough; and, contrary to what is usual in these structures, they are not always intimately attached to the surfaces on which they rest. Thus the nests, together with the enclosed animal, can be removed without injury. When thus removed they have the character of a complete bag of silk, and are sufficiently impervious to retain the enclosed air after long submergence in spirit. Finally, for *Chthonius* we are indebted to Godfrey (29) for notes on *Chth. rayi* L. Koch and *Chth. tetrachelatus* Preys. He describes the nests as built up usually of particles of earth and other chance objects, and lined

with silk, or less commonly formed in holes in stones, etc., the cavity in that case being lined with silk and the entrance closed in with a film of the same material*.

IV.

The nests throughout the Order, and for whichever purpose they are made, are less divergent in character than might be supposed from the foregoing details. Their essential features are everywhere much the same. The completed nest is a closed cell of silk with or without a complete or partial covering of extraneous matters externally. From this the animal has to cut or break its way out when it wishes to emerge. Viewed from above, the structure is roughly circular; but in other respects its form varies with the build of the animal and with the nature of the habitat. In the case of the more flattened animals which inhabit crevices the structure is often compressed. The silk in these circumstances is often spread over and attached to solid surfaces both above and below; and the films thus attached, which form the floor and roof of the nest, are continuous with and connected together by a circular wall. At other times, in spaces relatively wider, the film of the floor only is thus attached, and this film is continued above as a free, more or less convex, roof. In the case of less flattened animals living among stones, in vegetable débris, etc., the floor may be similarly attached and be surmounted by a pronounced dome; or the nests may be made in roundish cavities, or more frequently attached here and there to surrounding objects, and their form is then roughly globular. In all cases, however, there is variation from individual to individual, the animals enclosing themselves in convenient spots of varying character. The creature is always rather closely surrounded, though with ample room for free movement, and thus the differences in the size of the nests follow rather closely those of the makers. In the work of adult individuals there is a range of diameter from about 2 mm. to 10 mm. or more. The external covering of extraneous matters when it exists consists for the most part of earthy or vegetable fragments. It may be complete or partial, dense or sparse, and occur over the unattached parts of nests of whatever form. Some such covering is characteristic of the nests of many species; but in certain others it is invariably absent. The fragments are never over-spun, that is to say, bound on by threads passing over them, but they are always firmly attached to and form part of the structure. They never affect the interior, which is always free from foreign substances and smooth. The spun-material has the character of a thin dense whitish tissue, presumably largely impervious to moisture, and opaque, or

* Godfrey mentions that some of the nests of *Chth. tetrachelatus* had within them a second "silk cocoon of exquisite texture and quite separate from the first lining." This might result, perhaps, from the re-utilization of old nests. But Godfrey saw so many of these "double linings" that one can scarcely dismiss the subject with this suggestion.

nearly so. This tissue, unlike that of many spiders, does not tear with a distinct floss. Its consistency is comparable with that of thin silk-paper; and one would not suppose, even on examination with a strong lens, that it was composed of separately spun threads. With more ample magnification the construction becomes more or less obvious; but it is difficult to say what the arrangement is. Threads in extraordinary number and closeness, and most of them extremely fine, are crossed and re-crossed and turned about in irregular confusion. They appear to have been brushed on by long-continued effort, and no doubt in a viscid condition since they have coalesced to a large extent. The completed tissue is entirely without interspaces. When incomplete, threads of varying strength, in a more or less open, irregular meshwork, are observable*.

V.

From what part of the animal⁶ does the material for this tissue proceed? It was supposed that the glands were in the abdomen and that their ducts opened near the genital aperture in numerous separate spinnerets. This view was started by Menge, 1855 (6); and it remained unquestioned for more than thirty years. Even after Croneberg had shown it to be wrong, restatements of it continued to appear, not only in text-books, but in memoirs dealing specially with this Order: cf. Cambridge, 1892 (17). It was in 1887-8 that Croneberg (12, 14) showed that the glands indicated were really accessories of the genital system, and that the supposed spinnerets were merely part of the bristle-armature of the external genital-area. At the same time Croneberg found that in *Chelifer* (*Chernes*) there were glands in the cephalothorax with ducts opening in the chelicerae; and Bertkau (13), working during the same years and independently, made similar discoveries in *Obisium*. Both authors concluded that these were the real producers of the silk; and all that was required was confirmation from observations on living animals. Such observations, however, were not made; and in the meantime various considerations have confused the subject; so that, as stated recently by Godfrey (29), the spinning in this Order is still surrounded with uncertainty. Menge was well known to have supported his anatomical investigations with detailed descriptions and figures; and apart from these he had had living animals under observation. He had even described the movements of an individual which made part of a nest under his eyes. Croneberg and Bertkau, on the other hand, had arrived at their conclusions on morphological grounds alone. On such grounds, moreover, Supino (23) had dismissed these conclusions, regarding the organs in question as a poison-apparatus, and falling back as regards spinning-organs on a view

* The only previous note on this tissue known to me is by With (25). He examined nests of *Chelifer sculpturatus* Lewis, and was surprised to find that the threads were not independent but fused, so that a complicated system of thinner and thicker threads was formed. He adds that the structure was difficult to explain; and that the newly formed threads had perhaps fused before drying.

almost identical with that of Menge. Further, Bernard (18) had suggested that certain structures, which he believed himself to have discovered on the ventral face of abdominal somites V. to XI., were possibly the openings of spinning-glands. We have seen, however, that Menge was certainly wrong. With (27) has already stated that Supino was mistaken; and the same remark applies to Bernard, whose misconception was ridiculed at the time by Hansen (20) and soon abandoned by the author himself. But there were other difficulties. Ducts had certainly been seen in the chelicerae, but it was not clear that their openings had been fully made out; and Hansen had examined the supposed place of disemboisement in *Obisium muscorum* Leach with results which he was unable to regard as satisfactory. He may perhaps have had before him an adult male in which the spinning-function had degenerated*. However this may be, he seems to have regarded Croneberg and Bertkau's conclusions as justifiable; "but it ought to be examined if the animals actually do spin with these organs." So also With (27) has concluded that spinning is at least one of the functions of the chelicerae; but proof of it was still wished for.

VI.

The required confirmation of the correctness of Croneberg and Bertkau's conclusions is afforded by observations now recorded. The spinning is done by the chelicerae. These appendages are of two segments: a hand prolonged into a fixed finger, and a movable finger articulated to the hand; and they are provided with special structures, of which one is entirely and another partially or entirely comb-like. The whole appendage is relatively small in *Panctenodactyli*, and relatively large in *Hemictenodactyli*; and several differences in the special structures are characteristic of these main divisions. In all *Panctenodactyli* the movable finger is provided, on its outer margin just before the apex, with a small, almost transparent, more or less flexible, projecting structure known as the galea. In *Hemictenodactyli* this structure is present or absent; and in its absence the hard chitin of the finger, in exactly the same position, is raised to form a small, more or less convex, laterally compressed tubercle. Croneberg's researches in *Chelifer* (*Chernes*)—representing the first of these main divisions—showed that the ducts from the cephalothoracic glands passed into the hand of the chelicera, four or five into each, and thence into the movable finger, which they traversed to near the apex, where they entered the galea. Within the galea they distributed themselves into the small branches of that structure, and at the terminations of these branches they opened. Bertkau found in *Obisium*—representing the second main division—that the ducts similarly traversed the chelicerae

* Bertkau states of *Obisium* that the glands, which were well developed in all the females he examined, were absent in some of the males, though the ducts remained in the chelicerae.

to a point identical with that reached by those of *Chelifer* (*Chernes*). There was here no galea; but the ducts entered the hard tubercle replacing that structure, and on or near the margin of this tubercle they opened. The number of ducts in each chelicera was about ten—or, according to one of the later papers of Bernard (19), about seven; and one may note that on the tubercle of *O. muscorum* Leach, examined by Hansen, six minute openings appeared to exist. It is thus established that the galea and the tubercle which may replace it are correctly regarded as the external spinning-organs in this Order*. These structures bear no resemblance to one another; and no intermediate condition is known. The galea is obviously a sheath within which the ducts are carried forward beyond the apex of the finger. Its presence or absence does not appear to be associated with differences in the spinning or resulting tissue. Assuming Pantenodactyli to be the older group, it seems that the increasing size of the chelicerae in Hemictenodactyli may have rendered this projecting organ dispensable. The structures are always well developed, whichever one is present, in the young of both sexes and in adult females; and this no doubt is in relation to the spinning of moulting- and brood-nests. In adult males they may be fully developed or degenerate. In the former case it will be found, I believe, that regular winter-nests are spun; while in the latter case presumably the male spins but little or not at all after arriving at maturity. The character of both structures differs throughout the Order from species to species. Among the forms assumed by the galea the most complicated is that in which it is branched from a short stout base, the branches being re-branched, so that the shape of the organ recalls that of the antler of a stag. More usually it has a long, rather stout shaft, with about six small, simple branches distally. But it may be trifid or merely styloform. The tubercle may be rather high with a convex outline, or lower or longer and more flattened.

The other structures of the chelicerae, the combs, etc., have nothing to do with the spinning†.

* Thorell, 1883 (11), gave prominence to spinning (and chelate appendages) in the name "*Chelonethi*," with which he proposed to replace "*Pseudoscorpiones*." The spinning-openings were then supposed to be in the abdomen; but afterwards (1890), with references to Croneberg and Bertkau, he remarked on the increased propriety of the name, observing that the creatures not only possess chelæ and spin but spin with the chelæ (of the chelicerae). At the same time he proposed the name "*procursus textorius*" for the galea (16); and we find that Ewing (35) has already written "*spinneret*" for both galea and tubercle.

† It has been stated repeatedly that these combs—the serrula and lamina interior—manipulate the silk; but in reality they are not concerned in any way with the spinning-work, never coming into contact with the threads or with the spun-tissue. The mistake is attributable to Bernard (19), who converted into a direct statement an ingenious but incorrect suggestion of Croneberg's. To these structures another supposed silk-combing organ, said to be like the antenna of a Lamellicorn beetle, has been added by Shipley (30) and Warburton (31). This last is one of the inventions of Stecker (8; cf. Hansen 20); nothing like it exists in nature. The so-called "*flagellum*," which occurs in the position indicated, is merely a row or tuft of peculiar bristles; it is of unknown use and certainly not connected with spinning.

VII.

There remains the enquiry how are the nests built and spun; that is to say, how do the animals collect and fix the extraneous matters of the exterior, and how do they fabricate the spun-tissue?

Godfrey's field-work showed that the external coating was the first part of the work, the silk lining being produced afterwards and necessarily from within. This was evident from inspections of nests in various conditions of incompleteness; but the animals were not seen at work. To make the required investigations in the open was scarcely possible. It was necessary obviously to have captive individuals under observation; and this in conditions favouring the undisturbed performance of their functions, and at the same time permitting prolonged watching. Several naturalists, from Röscl 1755 (2) onwards, have kept the animals in captivity; and it has usually been found that nests were constructed; but Menge alone makes mention of the animals' procedure. He placed a *Chelifer* (*Chernes*) in a glass vessel and discovered next morning that a nest had been commenced. He found the animal still busy, by continued movements of the body somewhat like those of the spider *Clubiona*, increasing the thickness of the web; and he claimed from this to have seen the spinning. That the animal was so engaged there is no doubt; but since Menge was mistaken as to the position of the spinning-organs it is evident that no precise observation had been made. The writer's attempts to watch the animals in captivity commenced in 1904; and since that time one or more species have usually been under observation. They were housed in small flat cases of cork and glass, forming cells with an area of three square inches and a height of from a quarter to an eighth of an inch; and in these they lived in health for long periods. Their surroundings were made as natural as possible, and the nests they constructed were in most cases quite like those made in their natural habitats. The creatures were examined under moderate magnifications, the cells being placed bodily on the stage of the microscope. Such examinations were necessary from time to time; but much could be made out with no other aid than that afforded by a good hand-lens. The species whose nest-making was observed in detail were two of *Panctenodactyli*, *Chelifer cyrneus* L. Koch and *Chelifer latreillii* Leach; and one of *Hemictenodactyli*, *Obisium muscorum* Leach.

Chelifer cyrneus L. Koch—belonging to the subgenus *Chernes*, and eyeless—was the subject of most of the observations. It is a large heavily-built species; and the galea is long-shafted, equally developed in both sexes, and provided distally with six small branches*. The specimens were obtained from narrow

* These branches are less easy to count than might be supposed. For the present species, Tömösváry gives four and Schtschelkanowzeff five; yet there are undoubtedly six.

spaces under the bark of partly dead oaks; and the cells in which they were placed were provided with strips of decayed wood from these trees. The arrangement was such that narrow spaces were left between the strips of wood and the glass of the cells. Colonies thus established—strengthened by fresh importations from time to time—were under observation for two years; and at the time of writing, two cells contained together eleven nests: some on the floors of the cells, with a complete convex roof, and others of more compressed form in the spaces between the wood and the glass.

At various seasons certain of the animals, either young or adult, became distended—no doubt from accumulated nutritive matters—and it was in this condition that they enclosed themselves either for moulting, for brood-purposes, or for the winter. Such an individual restlessly perambulated the cell, investigating the corners and crevices, every now and then picking up with the palp-fingers and removing dead insects and other scattered objects; and occasionally, at such times, it detached fragments from the wood, taking hold of them with the palp-fingers and using considerable force. It was evidently prospecting for a position for the nest. At length, having decided on one, it was soon at work on it with the chelicerae, and usually by the following morning or evening it had arranged round itself a complete ring of fragments of wood, etc. It was now unsafe to abandon the post of observation, for the animal got to work with rapidity and within about twelve hours had generally completed the external coating or framework of the nest, the builder being then—except in those cases in which the glass formed the roof—entirely concealed from view.

The manner in which the animal constructed this framework and enclosed itself within was the subject of numerous observations. But the procedure may be indicated by taking the case of the making of a brood-nest with a complete convex roof, the observation of which extended almost from beginning to end. The distended builder was restlessly moving about in the morning, and in the evening of the same day was found to have taken up a position on the floor of the cell, where it had already surrounded itself with a ring of fragments. These were of wood and cork and mostly small—sawdust from the borings of *Dryocates villosus* for the most part—and they were all definitely placed in position and secured from within to the floor and to each other by threads of silk. They formed already the beginnings of the narrow circular wall of the nest. This was at 6 P.M., at which time the animal was within the circular space and full of business. For the continuation of its work it would require evidently a quantity of material, much of which would have to be procured from a distance. Coming up close to the wall, the animal extended the palps over it and felt about for fragments on the floor beyond. Finding some, it withdrew and proceeded with its work; or, failing to find any, it stepped over

the wall and explored the floor farther afield. Finding the necessary supply without going far, it returned to the nest by stepping backwards, going in over the wall abdomen first; or, more often, having to go to a distance, it returned with a forward locomotion, re-entering the nest head first. The fragments were found and picked up with the palp-fingers, whence they were immediately transferred to the chelicerae, the animal never carrying material home in the palps. Except in the case of large fragments it was not satisfied with one, but picked up a number in succession, transferring each as found to the chelicerae, its actions while thus engaged recalling those of a bird accumulating nest-materials in its bill. The smaller fragments were received between the fingers of the chelicerae, the fixed fingers going over and the movable galea-bearing fingers under them; and as the materials accumulated they appeared to be attached together by silk from the galeae. Larger fragments, while always kept in contact with the chelicerae, and apparently more or less attached with silk, were sometimes supported in part by the hand or other segments of the palps, or even on the dorsal shield of the head; and in this way was brought in at least one fragment nearly as big as the animal itself. At the conclusion of each collecting expedition the animal returned impatiently to the nest; but once within, it turned about and deliberated before placing the materials. At length, running the burdened chelicerae into some part of the top of the wall, it managed thus to release the fragments; and it now got to work at once, attaching them together and to those already placed by dabbing silk on their inner surfaces and stretching threads from one to the other. During this proceeding the palps were brought round so that the great hands and fingers of these appendages were close to the inner surface of the wall, the animal evidently directing the work by the sense of touch which the hairs and perhaps other sense-organs give to these parts. Occasionally it adjusted the fragments by propping them with the hands and fingers of the palps; and sometimes, but rarely, it held them between these fingers while the first few threads were being applied by the chelicerae. Apart from this, it constantly felt with the palps both the inside and outside of the wall, as if to ascertain how the work was progressing. One was particularly interested to see how it extended the palps over the outside for this purpose, its actions bringing to mind those of a bricklayer giving little taps to newly-placed work. There was an air of satisfaction about its behaviour, and with reason, for it was wonderful to see how the wall grew and began to assume the proper curve for the roof. From time to time, as soon as each collection of materials had been placed in position, off the animal went for another supply; and this continued fetching of fragments and building them in was maintained for hours. As the work proceeded, moreover, the task became more and more laborious, for the animal, no longer able to step over the wall, had to climb

up the inside and down the outside each time it went out, and up the outside and down the inside each time it returned; and further, there was increasing difficulty in fixing the fragments against gravitation as the structure converged towards the top of the roof. The animal was watched for five and a half hours, during which it worked untiringly and with care, with brisk and eager movements and without once resting. Its activity was remarkable. When I left it at 11.30 p.m. only a small aperture at the top of the roof remained to be filled in, and thus the framework of the nest was almost complete. It must be explained that the silk dried rapidly, the structure being firm from the first, so that it was little if at all damaged by the continued scrambling in and out of the animal. At the same time a certain elasticity was evident, and thus during the final stages of this part of the work—not seen in the present case—the animal would not be greatly obstructed in forcing its way in and out of the small decreasing aperture. Next day, at 7.30 a.m., the framework was complete, the aperture having been filled in, and the builder was thus entirely enclosed. The creature was still busy, however, within the nest. One could see that the palp-fingers were being applied from place to place, and the structure was temporarily raised or pushed out first in one part and then in another. The animal was evidently spinning, and at the same time re-adjusting the materials to some extent; and it even detached and threw out certain fragments, dried remains of prey etc., which had originally been built in.

The structure thus made consisted of a vast number of irregular, mostly small, fragments of wood and cork fastened together by silk attached to their inner surfaces and extending from one to the other; and the arrangement was such that the interior had a regular approximately even surface. The silken attachments—seen by looking down between the fragments—had the character of an open irregularly joined-up meshwork, of which the threads were of varying thickness, most of them relatively stout. This meshwork ought perhaps to be regarded as the essential frame of the structure; the use of fragments is probably necessary in nests entirely unattached above but otherwise it is not indispensable; for the animal is able, at least in certain positions, to make nests of spinning-work alone. The task of bringing the nest to the condition now indicated had entailed much work; but what remained to be done was more laborious and occupied a longer time. This additional work consisted of long-continued spinning, the meshwork, the inner surfaces of the fragments, and in fact the whole interior, including the floor, having to be covered with silk, until at last every part was lined with the almost paper-like tissue already described.

The making of nests such as that above considered, though showing well the manipulation of the extraneous materials, offered but moderate facilities for observing the spinning. This was better seen in nests made in the spaces between the strips

of wood and the glass. In such a nest the wood formed the foundation for the floor and the glass that for the roof, the built part consisting of a circular wall extending from one to the other. Here one could see something, not only of the making of the framework of the wall, but also of the subsequent spinning, which latter was obscured in nests of the former character. The general proceedings of the animal were easily observed; but it was less easy to make sure of the precise character of the spinning, the task of following moving organs under the magnification required being, even in the most favourable conditions, somewhat difficult. However, it was seen that the silk proceeded from the distal part of the galeæ—there was no doubt that it issued from the tips of the little branches there situated—whence it was drawn as separate, highly viscid, very fine threads. These threads, several from each galea, either remained separate or coalesced into stouter ones, all those from each galea sometimes going to form a single thread. The spinning involved small continuous forward and backward movements of the body, such movements being derived from the joints of the legs without necessary replacement of the feet. The small forward movements brought the galeæ into contact with the objects to which silk was being applied, or with the tissue which was being augmented, and from attachments thus made threads were drawn out during the small backward movements, at which time also there were lateral movements of the chelicerae, the galea-bearing fingers being swung widely open. These small movements of the body, moreover, brought the chelicerae, not always to the same spot, but sometimes a little above or a little below, or a little to the right or to the left; and the chelicerae themselves, it may be explained, are much more mobile than might be supposed, being capable of considerable extension both forwards and laterally. While making the framework the animal was seen to bring the chelicerae into contact with the glass and by small rapid movements to brush on minute confused attachments of separate threads. During this part of the work the creature moved about freely, and the threads thus attached, usually coalescing into one from each galea, were carried from place to place, from roof to floor, or from either of these to the inner surfaces of collected fragments, or from one fragment to another. The threads coalesced at various distances from the galeæ and not all of them at the same point, and since they fused at once either before or after coalescing with other threads or with whatever object they came in contact, the irregular meshwork soon resulted. As the animal continued to work the meshes became closer and closer, till little by little they were filled in. At the same time the animal laboured to cover the floor and roof with silk. At frequent intervals, often throwing back the palps along by its sides, it settled down to long-continued spinning; and at such times it maintained for hours the continuous movements of the body and of the chelicerae already mentioned. By this means silk was rapidly

brushed on to the interior, first in one place and then in another. It fused at once to the substratum, the exceedingly fine threads now usually fusing separately without coalescing one with the other. This was well seen on the roof, where the threads fused to the glass in more or less parallel order in series of several running side by side. An appearance similar to that here presented would be obtained perhaps if it were possible to take the lines from a sheet of music, obliterate one here and there, and turn the rest backwards and forwards in irregular fashion one over the other. The number of threads in a series varied, and in the present species not more than five were counted—that being the usual number; so that it appeared that one or more of the branches of the galea had usually been inactive. With the two galeæ the animal could thus produce at least ten threads at a time; and it will be understood that the original parallel order was soon lost in the general confusion of a closed layer. Continuing thus to work at intervals for many days or even weeks, the animal at length produced the final dense tissue over every part of the interior of the nest. In the case of a perhaps unusually dense moulting-nest, this part of the work occupied the indefatigable energy of the animal during six weeks, the completed structure thus costing incredible labour.

Chelifer latreillii Leach—belonging to the subgenus *Chelifer* s. s., and provided with eyes—was the subject of similar though less numerous observations. The galea is here shorter-shafted; and its distal half is provided with small branches, which in the female—the organ is degenerate in the adult male—are six in number. Specimens were obtained from tussocks of *Ammophila arenaria* on sand-dunes; and the cells in which they were kept were provided with leaves of that grass and with sand. Brood-nests only were made—there were no immature individuals to make moulting-nests—and little need be said of them since the animal's methods were identical in all essential matters with those of *C. cyrneus*. The extraneous materials employed were grains of sand, which the animal carried in the chelicerae. Only a little sand was used, however, the spun-tissue being slight in texture and for the most part uncovered externally. The silk was seen to proceed from the galeæ, as before, and that deposited on the glass ran similarly in irregular more or less parallel series; in these, in the present case, six threads sometimes occurred, presumably one from each of the six branches of the galea.

Obisium muscorum Leach, the remaining animal observed, is of vastly different type. It is longer-legged and less solid; and in place of the two dull eyes of *Chelifer* s. s. there are four shining with a white lustre. The chelicerae are large and without galeæ. The hard laterally compressed tubercle which replaces the galea has, especially in the female, a bold convex margin, on or near which, as already stated, Hansen more or less satisfactorily detected six minute openings. The animal is common and

easily obtained; but since it requires constantly moist conditions there are difficulties in keeping it for long periods. However, a few were maintained in health for several months; and two females made brood-nests both attached in part to the glass. It had been supposed that the differences in the chelicerae, more particularly the absence of galeæ, would correspond with differences of method; but the animal's proceedings appeared to be identical with those of *Chelififer*. As with those animals, the framework of the nest was rapidly constructed, the extraneous matters being carried in the chelicerae; and no differences were observed in the manner of spinning or in the tissue. The silk was seen to proceed from the tubercle in several very fine threads, which, more especially during the earlier part of the work, were apt to coalesce, those from each tubercle often forming a single thread. At other times, that is during the formation of the dense tissue, the threads more often remained separate, fusing thus to the substratum, and those deposited on the glass ran in irregularly parallel series, usually six together, presumably one from each of the pores of the tubercle.

It will have been noticed that the number of spinning-openings appears to have been six on each chelicera, twelve in all, in all three species, the presence or absence of the galea counting for nothing in this respect; but this number is not necessarily universal. The branching of the galea, for instance, is a variable feature from group to group. For the rest, however, it may be predicted that the general lines now indicated are those on which all the animals of this Order, whether possessing the galea or not, set about the construction of their nests.

VIII.

Summary.—Pseudoscorpiones make nests in part or wholly of silk from their own bodies. They enclose themselves in them for moulting, for brood-purposes, and in some cases for hibernation. Such nests are closed cells of spun-tissue with or without an external covering of extraneous matters. They are roughly circular, but their form differs with the build and habitat of the animal. They may be attached above and below to the solid surfaces of narrow crevices and thus flattened, or they may be attached below only, in which case they have a free convex roof, or, again, they may be fixed here and there to surrounding objects and roughly globular. The external covering, when it exists, consists of earthy or vegetable fragments, which are not bound on to the structure but firmly attached to it. The interior is always free from foreign matters and smooth. The spun-tissue is thin and dense, almost like silk-paper. It is composed of innumerable threads crossed and re-crossed and coalesced in irregular confusion and without interspaces. The material is derived from glands in the cephalothorax, whose ducts traverse the chelicerae to near the apex of the movable finger, and open at

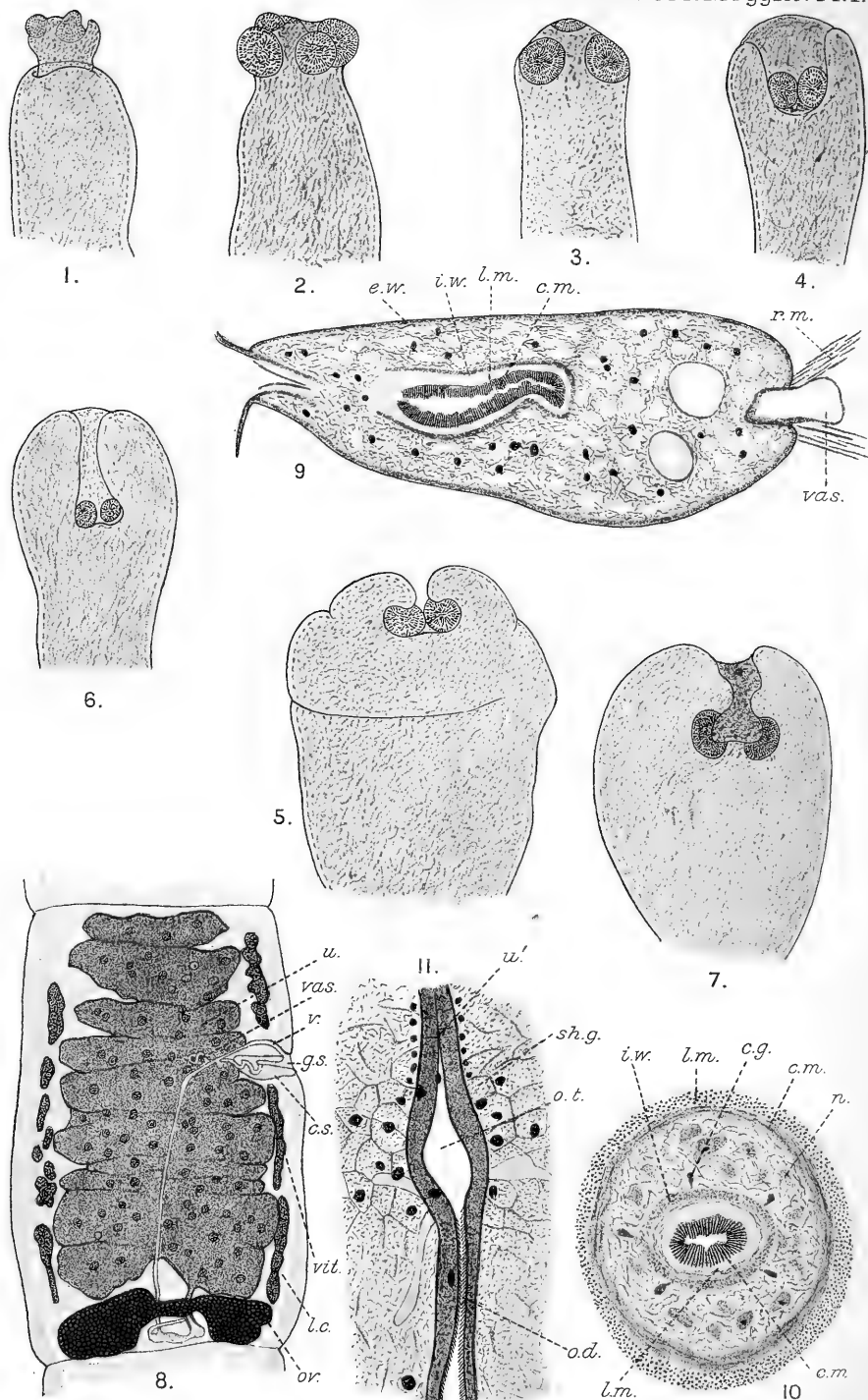
the tips of the branches of the galea or on or near the margin of a tubercle which replaces that structure in some groups. The spinning is thus done with the chelicerae, the galea or tubercle being the structure immediately concerned; and the presence or absence of the galea does not appear to be associated with differences of method or in the tissue. The combs etc. of the chelicerae have nothing to do with the silk. All the nest-making is done from within, the animal gradually imprisoning itself. The construction of an external framework is the first part of the task; and when this has a coating of extraneous matters the animal frequently goes out to collect materials. These it picks up in the palp-fingers, transfers them to the chelicerae, and returns thus laden to the nest, where it attaches the materials together and to those already placed by applying silk to their inner surfaces and stretching threads from one to another. The silken attachments form an open irregular meshwork, which is the essential frame of the nest, and is constructed in some cases without the use of extraneous matters. The silk is drawn from the galea or tubercle in several separate viscid very fine threads, which remain separate or coalesce, all those from each galea or tubercle sometimes forming a single thread. The spinning is associated with continuous forward and backward movements of the body and with lateral movements of the chelicerae. During the earlier parts of the work, when attachments are being made from place to place, the threads usually coalesce, and since they fuse at once, either before or after coalescing with other threads or with whatever object they come in contact, the irregular meshwork soon results. Afterwards the animal settles down to long-continued spinning, and silk is rapidly brushed on to the interior, first in one place and then in another. The threads now usually fuse separately, being applied in more or less parallel series of several side by side; and when both galeae or tubercles are used together ten or twelve threads may be deposited at a time. The animal continues thus to work at intervals for days or even weeks, till the final dense tissue is at last produced over every part of the interior of the nest. The methods of three species, representing both main divisions of the Order, were observed in detail; they were essentially identical and probably characteristic of all Pseudoscorpiones.

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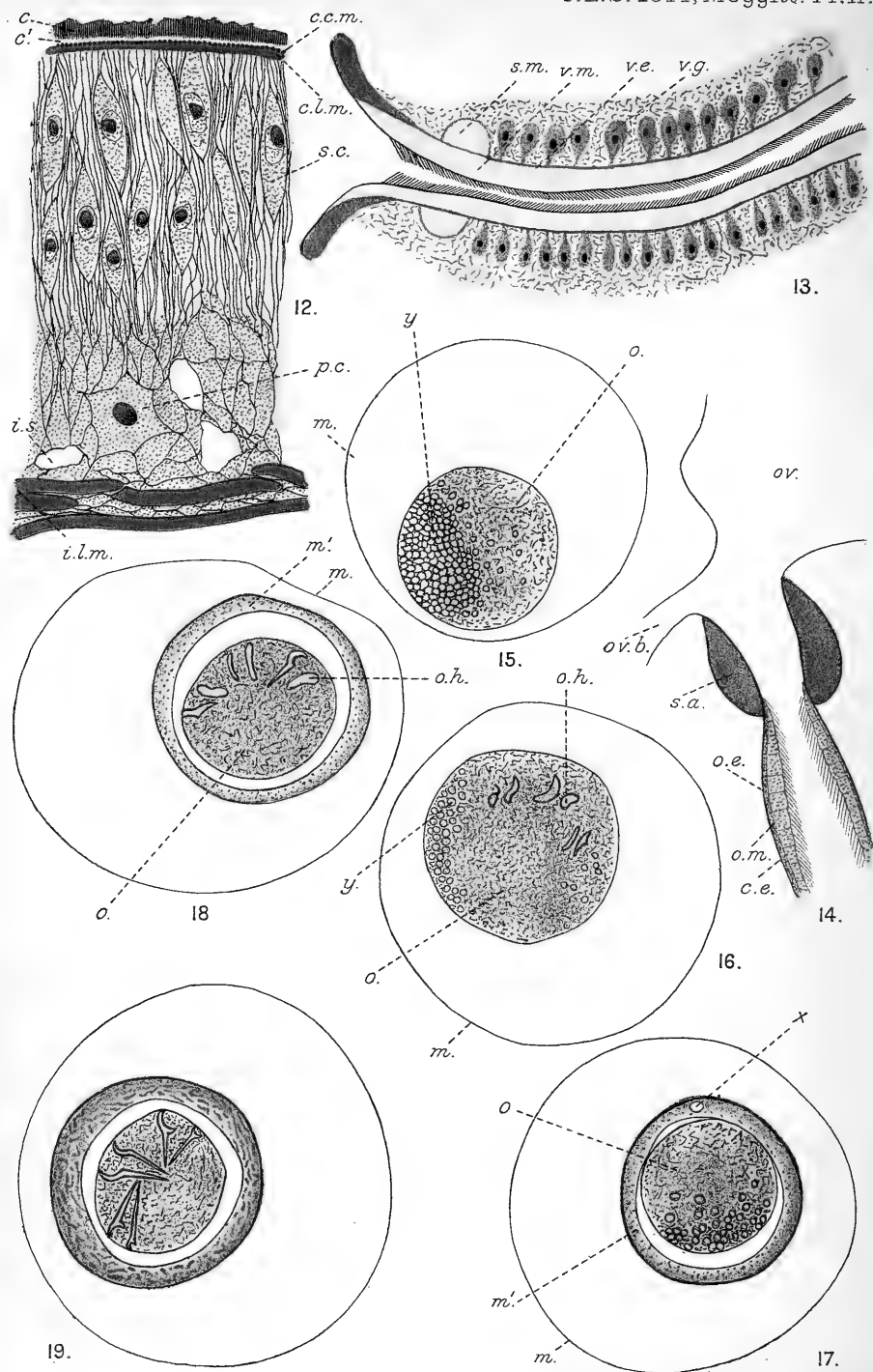
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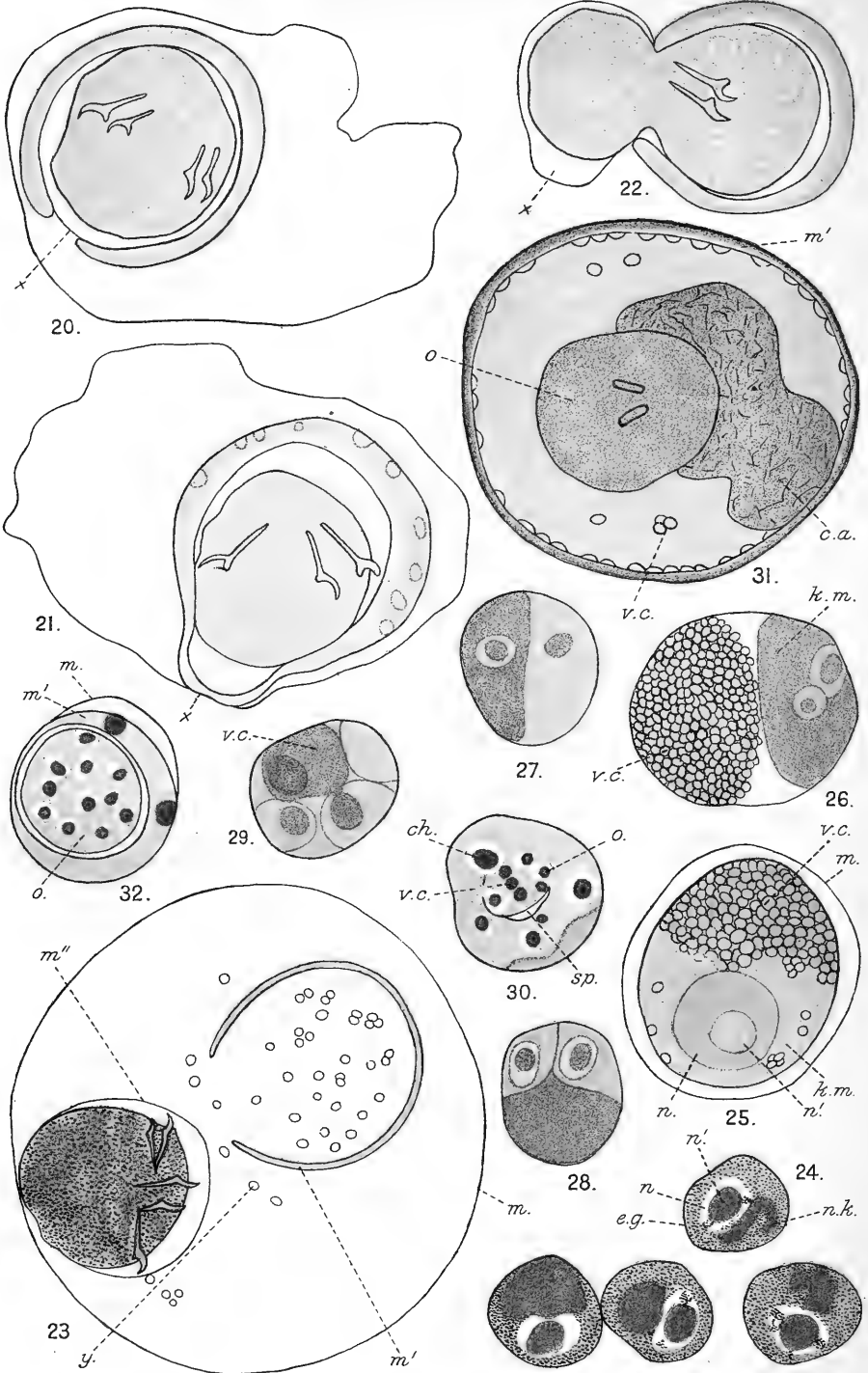
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STRUCTURE OF ICHTHYOTÆNIA FILICOLLIS.

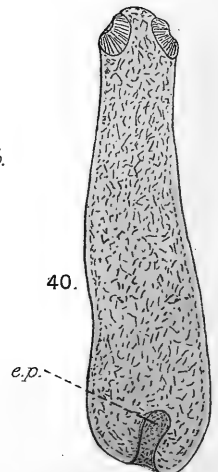
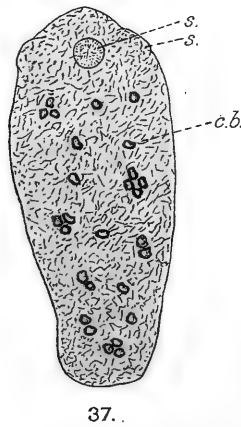
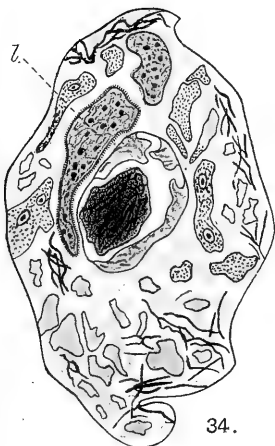
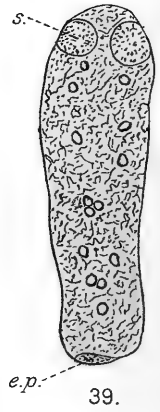
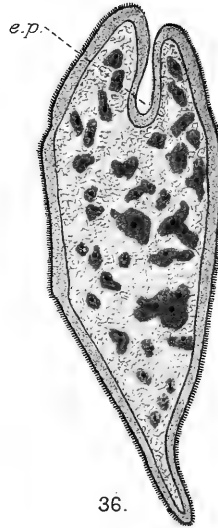
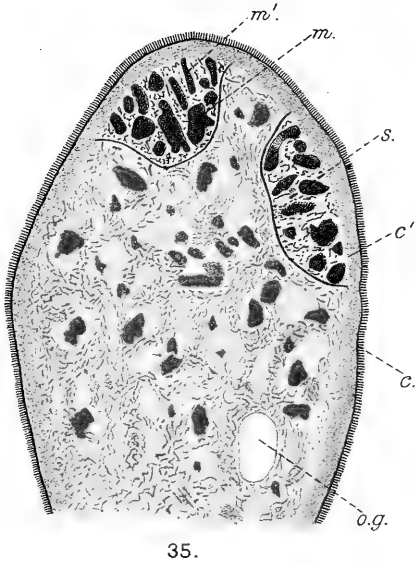
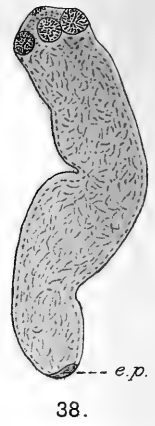
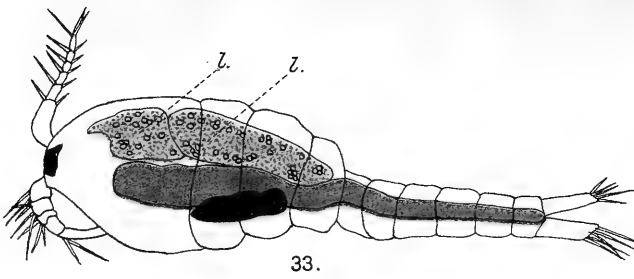




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STRUCTURE OF ICHTHYOTÆNIA FILICOLLIS.





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8. The Structure and Life-History of a Tapeworm (*Ichthyotænia filicollis* Rud.) Parasitic in the Stickleback. By F. J. MEGGITT, M.Sc. (Birm.), Board of Agriculture and Fisheries Research Scholar, University of Birmingham *.

[Received November 17, 1913: Read March 3, 1914.]

(Plates I.-IV.† & Text-figures 1-5.)

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INTRODUCTION.

Ichthyotænia filicollis Rud. (= *Tænia filicollis* Rud.) is a species the life-history of which, like that of most *Ichthyotæniæ*, is practically unknown. No successful infection experiments have been carried out upon any member of the genus, and it was therefore thought that a connected account of the whole life-history would be of service in establishing a complete diagnosis of the family. In carrying out this work it was found that the only two complete descriptions of this species, those of Kraemer (10) and Benedict (3), are said by La Rue (12) to be descriptions of other species: if this be correct, then there is at present no paper giving a detailed and accurate study of this species. The paper is therefore divided into two parts, the first being a detailed account of the anatomy of the specimens obtained, compared with the descriptions of Kraemer and Benedict, and the second an account of the life-history as far as it could be determined.

I wish here to express my indebtedness to Professor F. W.

* Communicated by Prof. F. W. GAMBLE, F.R.S., F.Z.S.

† For explanation of the Plates see p. 137.

Gamble, F.R.S., for the very valuable help he has given me in the course of this work by his criticism and advice. My thanks are also due to Professor G. S. Brady for identifying specimens of *Cyclops varius* Lilljeborg submitted to him.

ANATOMY.

Historical.

This species was first described by Rudolphi (21). He found two species of Cestodes, one in the intestine of *Perca fluviatilis*, and one in that of *Gasterosteus aculeatus*, and called them *Tænia ocellata* and *T. filicollis* respectively. In his original descriptions there is very little to distinguish between the two species.

Early investigators, Bellingham (1), Dujardin (8), Diesing (7), and Cobbold (6), confined themselves to external characters, Zschokke (26) being the first to describe the internal anatomy. Later, Kraemer (10) made an exhaustive study of the two species, and concluded that there was no essential difference between them: in the same paper he gave a number of characteristics peculiar to fish *Tæniæ*, and suggested that they might form a special group. Still later, Lönnberg (15) separated them under the generic name of *Ichthyotænia*. Riggenbach (20), for the first time, summarised the investigations on the genus and added several new species to the list. In 1899, Railliet (19) showed that *Tænia ambigua* Duj. is synonymous with *T. ocellata* Rud. and *T. filicollis* Rud., and that therefore the genus *Proteocephalus* Wein. (25) is synonymous with *Ichthyotænia*: the first being the older name, should be adopted according to him. Benedict (3), who confirmed Kraemer's description and elucidated a few fresh points, adopted this name.

The latest paper upon the subject is that by La Rue (12). He asserts that *Tænia filicollis* Rud. and *T. ocellata* Rud. are two separate species. The species which Kraemer described under those names, La Rue asserts was not *T. filicollis* nor *T. ocellata* but an entirely new species (*P. fallax* La Rue). He further says that Benedict did not describe either of Rudolphi's species, the species actually described being *P. exiguus* La Rue. Zschokke (26) also, according to him, described *P. dubius* La Rue, not *T. filicollis* Rud.

Tetracotylus (Monticelli, 18) he does not consider to be synonymous with *Ichthyotænia*. He adopts the generic name *Proteocephalus* on account of its priority: "I cannot regard the objections of Lühe (16) as adequate for its rejection." This paper is merely a preliminary note to a monograph he is about to publish.

From the brief historical account just given, it is obvious that the nomenclature of the group is in a state of great confusion. This is chiefly due to the vague descriptions of the early investigators, most of them being based upon characters, such as the scolex, which are far too variable to be utilised for

classification. Riegenbach (20) lists 29 species, of which only 7 are satisfactorily described. At the present time, it is impossible to say with certainty whether La Rue is right in retaining the species *Tenia filicollis* Rud. and *T. ocellata* Rud. The only correct part of Rudolphi's description is that referring to the scolex, and since the scolex is very variable, Rudolphi's species cannot be determined with any degree of certainty. The question can only remain in abeyance until the publication of La Rue's monograph.

It cannot be said, however, that La Rue is justified in retaining the generic name *Proteocephalus*. As Lühe (16) has shown, this name was used by Blainville (4) for a family of Cestodes containing *Caryophyllæus*, and for that reason should be abandoned in favour of the next oldest name, *Ichthyotænia*. In the same paper in which La Rue rejects the name *Ichthyotænia*, he proposes the name *Monticellia* for the genus *Tetracotylus* Mont., Braun (5) and Lühe (16) having shown that the latter name was proposed by Filippi to designate a group of immature Trematodes. He thus admits the principle upon which Lühe's objections are based.

Occurrence.

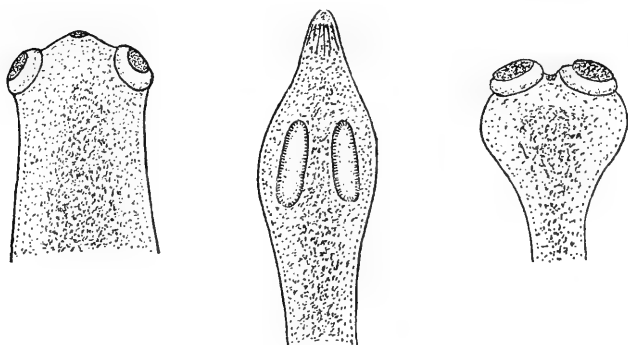
The specimens studied were collected from the intestines of a number of sticklebacks (*Gasterosteus aculeatus* Artedi) taken from the Edgbaston Reservoir. The numbers in a single host varied from one to twenty-five. Almost every fish in autumn was infected with one or more of these parasites, 75 per cent. of which were adult: in winter, the number of infected fish was considerably smaller, and adults were rare; while in spring, the proportion of adults again increased. Adult specimens were found, however, all through the months September to June, but while their proportion to young forms was 75 per cent. in the first month, it was only 15 per cent. in March. Von Linstow failed to find it adult at all in winter, and Zschokke only noticed it three times.

External Characters.

The length of adult specimens varies from 24 to 33 mm., the breadth from 1.0 to 1.2 mm. The head is almost continuous with the neck and is only slightly globular except when violently contracted (text-fig. 1): in Kraemer's specimens it was spherical and sharply marked off from the neck. It is furnished with four suckers, two dorsal and two ventral, and at its apex is a fifth, which is not very well developed although apparently functional. The shape and size of the head and suckers are subject to considerable variation. The whole region of the head anterior to the suckers can be retracted (Pl. I. fig. 5): or the retracted area may even be so large as to include the suckers themselves (Pl. I. figs. 4, 6, 7)—in the latter case, they are hidden in a deep vertical fissure, and can only be seen by staining, while the

scolex appears to have a terminal depression similar to that of *Schistocephalus dimorphus* Crepl. On the other hand, the suckers may stand out as small cups at the four corners of the base of a tetragonal pyramid, the apex being formed by the fifth sucker (Pl. I. fig. 2): the scolex may also be inserted in the neck like a cork in a bottle (Pl. I. fig. 1). It is obvious, therefore, that the shape of the scolex is a character to which little importance can be attached. In life the head undergoes a regular series of changes, passing from an extremely elongated phase to a violently contracted and spherical one (text-fig. 1).

Text-figure 1.

Movements of scolex of *Ichthyotania filicollis*. $\times 142$.

The diameter of the head varies from $\cdot 166$ to $\cdot 2$ mm., and of the suckers from $\cdot 04$ to $\cdot 07$ mm. The neck is relatively long, and occupies about a quarter of the whole length. The first proglottis separated from it is much broader than long, its dimensions being $\cdot 192$ – $\cdot 397$ mm. broad \times $\cdot 1$ – $\cdot 166$ mm. long. The total number of segments varies from 24 to 33. Kraemer states that the first proglottis is much longer than broad; while Benedict figures two varieties, in one of which it is longer than broad, and in the other is broader than long. Lühe (17) gives it as longer than broad. The following table gives the external measurements according to various observers (Table A). Posteriorly, the segments become longer in proportion to their width, until the penultimate proglottis is $1\frac{1}{4}$ –2 times as long as wide. The posterior proglottis is rounded at the tip, and at its apex is the excretory pore. In my specimens this was often very prominent, opening on a small triangular papilla.

The separation of the proglottides from one another is very indistinct, being indicated in the posterior portion of the strobilus only by a slight notch.

The genital openings are lateral, and alternate irregularly. According to Benedict, there is a small genital sinus, while

TABLE A.

	Length of body.	Breadth of body.	Diameter of head.	Diameter of suckers.	Breadth of neck.	First proglottis.	Number of proglottides.	Length of neck.
Kraemer	60	2	·114	·038	0·76	·228 wide × ·342 long.	50-120	$\frac{1}{4}$ — $\frac{1}{2}$
Benedict:								
1st variety ...	12-16							$\frac{2}{3}$
2nd " ...	15-25							$\frac{2}{3}$ — $\frac{4}{5}$
3rd " ...	38	·8	·12	·04	·10-12	·12-20 wide × 1·16 long.	40	$\frac{1}{2}$
Lühe	30-100	2	·114				50-120	$\frac{1}{4}$
Meggitt	24-33	1·0-1·2	·166-2	·04-·07		·192-397 wide × 1-166 long.	24-33	$\frac{1}{4}$

TABLE B.

	Diameter of calcareous bodies.	Thickness of 1st layer of cuticle.	2nd layer of cuticle.	Circular muscle-layer.	Longitudinal muscle-layer.	Sub-cuticular layer.	Cells of sub-cuticular layer.	Diameter of their nuclei.	Diameter of their nucleoli.
Kraemer	·003-·005	·003	·005	.....	.....	·06	·057 × ·02	·008	
Benedict	·005	·0015	·002	·031	.....	·025			
Meggitt .....	.....	·0033	·002	·0012	·002	·066	·02-·028 × ·007	·005	·003

All measurements in millimetres.

Kraemer states that vagina and cirrus open directly to the exterior. My own specimens confirm the former statement.

Histology.

The body is covered by a two-layered cuticle (Pl. II. fig. 12). The outermost layer is dark-staining and rough in outline, and is split up by vertical clefts into a great number of fine hair-like processes. The whole appearance is that of a cast cuticle. A similar cuticle is present in *Schistocephalus dimorphus* Crepl., and this Kiessling (9) considers to be a disintegration product of the underlying layer: it is probable that this is true of *Ichthyotenia filicollis* also. Under this cuticle is a feebler-staining homogeneous layer. According to Kraemer, there is a third layer ("Cutis") underneath this: in one or two cases in my specimens it has appeared as though there were a third layer, but this is probably only an optical effect. Benedict does not mention it at all.

Following the cuticle is a layer of circular muscle-fibres, and then one of longitudinal muscle-fibres. Internally is a sub-cuticular cell-layer, composed of spindle-shaped cells, $\cdot 02\text{--}\cdot 028 \times \cdot 007$ mm., drawn out into delicate protoplasmic processes internally, and possessing a prominent nucleus, $\cdot 005$ mm. dia., and nucleolus, $\cdot 003$ mm. dia.

The structures above-mentioned appear to vary greatly in size according to different investigators (Table B); it is apparent, therefore, that their size is a character too unstable for classification.

Under the sub-cuticula is the parenchyma. This consists of polygonal cells, with a varying diameter of $\cdot 0046\text{--}\cdot 008$ mm., with nuclei $\cdot 0023$ mm. dia. The cell corners interlace with one another to form a loose meshwork enclosing intercellular spaces, the meshwork being closer externally and less compact between the various organs. The intercellular spaces are often empty, but more usually are filled with a feebler staining granular mass which Kraemer thinks is an excretory product of the parenchymatous cells.

Forming a regular layer under the cuticle in the more posterior part of the body are large numbers of rather small calcareous bodies. They are oval and stratified, rather like starch-grains. In the larval cestode they are much longer and not so stratified, and are scattered irregularly over the body; they show very distinctly under the cuticle, and appear as if actually on the body surface.

There do not appear to be any oil globules comparable with those mentioned by La Rue (11) in *P. filaroides*. If the Cestode be examined in water, numerous transparent bubbles may be seen attached to the body and gradually growing larger; these may correspond to the oil globules and be due to the water round the specimens causing the minute invisible oil droplets on the body to coalesce into larger drops.

Musculature.

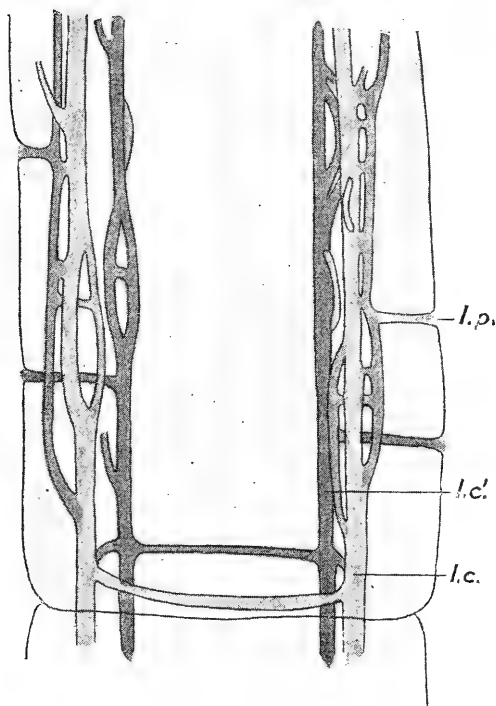
The musculature of the body consists of circular and longitudinal muscles (already described) under the cuticle, and more powerful inner longitudinal muscles (Pl. II, fig. 12). These latter are arranged in bundles, which run in the outer layer of the parenchyma and have a diameter varying from .008 to .0103 mm. (Benedict, .0015 to .004 mm.); anteriorly they diminish in size, although in the scolex anteriorly to the suckers they occasionally have a diameter of .0092 mm. The single fibres of which they are composed are .0035 mm. dia. (Kraemer, .007); occasionally spindle-shaped nuclei, .0028 \times .0092 mm., with a prominent nucleolus, .0023 mm. dia., are to be seen, the long axis of the spindle being parallel to that of the fibre. In the body, and especially in the neck, large fibres pass dorso-ventrally between the longitudinal muscle bundles. According to Benedict, "a loose sheet of circular muscle-fibres weaves around the longitudinal bundles. Large fibres pass in a transverse direction between these muscle sheets. The divisions between the proglottides are formed by the interlacing of these fibres with similar ones which cross them at right angles, both sets being here much more complicated than in other regions." He does not figure them, however, and they do not appear to be present in my specimens.

The musculature of the scolex consists of prolongations of the inner longitudinal muscles together with scattered dorso-ventral and sagittal fibres. The suckers have equatorial, meridional, and inner radial muscle-layers; they are covered by a continuation of the body cuticle, which is not absent, as Kraemer states, from their cavities.

Excretory System.

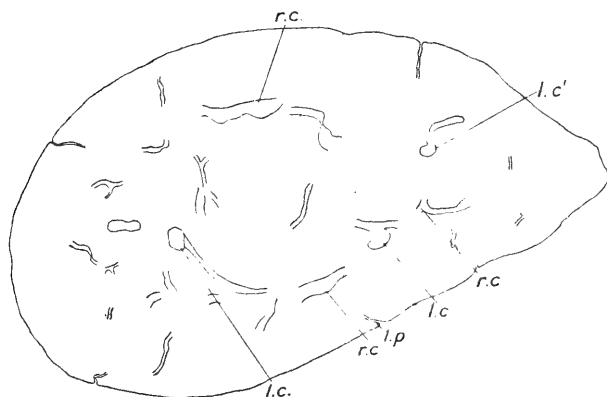
The excretory system consists of four main longitudinal vessels, two dorsal and two ventral, which run, internally to the longitudinal muscles but externally to the yolk-glands, from the scolex to open at the posterior end of the body. They are not, as Kraemer states, of equal diameter, but are unequal, the two dorsal being .0045 \times .0068 mm., and the two ventral .002 \times .015 mm. In the scolex they end in a circular commissure, .0023 mm. dia., just under the suckers (text-fig. 3). Outside their course in the neck is a system of fine canals forming a complicated plexus from which other fine canals lead, either to the exterior or to the four longitudinal canals. These "foramina secundaria" have, according to Kraemer, a swollen portion at their opening, while the opening itself is guarded by a wisp of hairs. I have never had the good fortune to see the dilatation, the canals apparently having a uniform diameter, .0017 mm., throughout their entire course; the wisp of hairs also I have never seen, although the outer cortex at places presents rather a hair-like appearance. La Rue (11) states: "There exists a wide variation in the types of structures which

Text-figure 2.



Main excretory vessels of a proglottis: reconstructed from camera-drawings of sections. *l.c.*, *l.c'*, ventral and dorsal longitudinal excretory vessels; *l.p.*, lateral excretory pore.

Text-fig. 3.



Transverse section through the neck, showing the excretory plexus. *l.c.*, *l.c'*, ventral and dorsal longitudinal excretory vessels; *l.p.*, lateral excretory pore; *r.c.*, circular commissure. $\times 435$.

are grouped under this name. The 'foramina secundaria' described by Kraemer for *P. ocellata* and *P. torulosa*, and by Riggenbach for *P. fossata*, *P. abscissa* and *Corallobothrium lobosum*, are muscular pulsatile vesicles which open at the posterior lateral margin of each proglottid. Benedict finds no such vesicles for *P. ambloplitis* or for *P. ocellata*, nor do any of the secondary excretory openings seen by me come under the type described by Kraemer and Riggenbach." Throughout their entire course, the longitudinal canals give off many side branches which anastomose with one another and with the main canal; in many cases they end blindly in parenchymatous spaces. At irregular intervals, other lateral branches are given off; these gradually diminish in width and finally open to the exterior. In the neck this anastomosis is much more evident, at times the main canals being lost in the plexus formed.

At the posterior limit of each proglottis, the four longitudinal canals are joined by a circular commissure whose lumen is equal to that of the canals.

The four canals open posteriorly in a notch at the apex of the last proglottis. There does not appear to be any such "Endblase" as Kraemer figures, the canals meeting at one point, from which a common canal leads to the exterior. Instead of the notch there is often a triangular projection at the apex of which is the excretory pore. In young forms there is a very pronounced "Endblase" (Pl. IV. fig. 40) into which the excretory canals probably open, but this disappears in older specimens.

Nervous System.

Owing to the difficulty of staining it, I have not been able to make out the nervous system at all satisfactorily. Anteriorly there is a nervous mass, the "brain," lying between the four suckers and just under the fifth; from it are given off two longitudinal nerve-trunks which run down the lateral margins of the strobilus externally to the excretory system. Benedict describes in addition, four transverse trunks arising from the anterior nerve-mass, each running straight out between the two suckers; about halfway to the margin of the scolex each branches into two secondary trunks, which run at right angles to their previous course as far as the corresponding sucker.

Male Organs.

The testes are spherical bodies, .055 mm. dia., about 40 in number, scattered throughout the entire space between the ovaries and the anterior edge of the proglottis; there is no central layer from which they are absent. Each is tightly invested with an exceedingly delicate tunica propria, not, as Benedict figures, in a loose membrane. In transverse sections they appear hollow, with a cavity divided by septa into a number of small compartments filled with granular matter. Minute vasa efferentia lead from them to a common vas deferens,

·0184 mm. dia. In the centre of the proglottis, this is coiled into a spherical ball, in the coils of which lie the spermatozoa. The walls appear structureless, but have occasional nuclei, $\cdot0046 \times \cdot0011$ mm., scattered along them. Benedict states that the coils are bound together by parenchymal strands, but these I have not been able to see. From this coiled portion, a short duct leads to the cirrus-sac, but before entering it, decreases in diameter to $\cdot008$ – $\cdot009$ mm.

The cirrus-sac itself (Pl. I. fig. 9) is oval, slightly constricted in the middle, and stretches about $\frac{1}{3}$ – $\frac{1}{4}$ across the proglottis, extending some distance beyond the vitellaria. Its small size in my specimens is surprising, since both Kraemer and Benedict figure it as reaching to the middle line of the proglottis, and its comparative size is one of the characters used for specific distinctions. Its walls (Pl. I. figs. 9 & 10) consist of outer longitudinal muscles, $\cdot0023$ mm. thick, and inner circular muscles, $\cdot0023$ mm. thick, with an exceedingly delicate cuticle surrounding them. The basal end of the cirrus-sac is turned rather obliquely towards the dorsal side of the proglottis. Its walls bend back to form a small tube which becomes united with the wall of the vas deferens. This latter, just within the cirrus-sac, has a slight muscular coat which gradually becomes thicker and passes into the muscular coat of the cirrus. The vas deferens is coiled once before opening into the cirrus.

The latter is an almost straight cylindrical tube, without the enlarged distal portion figured by Benedict. It consists of an outer layer of longitudinal muscles $\cdot003$ mm. thick, an inner one of circular muscles $\cdot0023$ – $\cdot004$ mm. thick, and a cuticle bearing fine bristle-like projections externally. The lumen here is $\cdot0046$ mm. dia. The external cuticle of the body tucks in at the opening of the cirrus-sac and lines the inner wall of the cirrus for some distance. Scattered along the course of the cirrus-tube and opening into it are numerous pear-shaped glands, $\cdot0034 \times \cdot0009$ mm.

The space between the inner tube and the wall of the cirrus-sac is filled with fibrous tissue containing many nuclei, $\cdot0023$ mm. dia., but I have been unable to see the definite fibres figured by Benedict. At the posterior end of the sac are muscles extending from the cirrus-tube into the parenchyma, and probably serving for retraction.

Female Organs.

The aperture of the vagina is $\cdot008$ mm. in diameter and is just anterior to that of the cirrus-sac. A circular sphincter muscle (Pl. II. fig. 13) encloses the vagina a little within the aperture; it is hemispherical in section, with a diameter of $\cdot008$ mm. The vagina itself runs back to the middle line of the proglottis, turns at right angles to its former course, and finally opens into the oviduct at the posterior end of the proglottis (text-fig. 4). Its

walls consist of an inner ciliated epithelium—which appears to pass into the cuticle of the body—a muscular layer, and an outer epithelium; altogether the wall is $\cdot 0034$ mm. thick, and the lumen of the tube $\cdot 003$ mm. dia. Along its course, but particularly near its opening to the exterior, are numerous glands, $\cdot 004$ mm. dia. at their widest part $\times \cdot 007$ mm. long, with distinct nuclei, $\cdot 0011$ mm. dia., and having fine ducts opening into the lumen of the vagina. Just before it opens into the oviduct, the walls have a slightly different character. They diminish in width to $\cdot 0029$ mm., the muscular layer nearly disappears, and the main thickness of the tube is due to a layer of cubical epithelium, similar to that lining the cavity of the oviduct. The opening of the vagina into the oviduct is very small.

The ovary is two-lobed. The lobes are elliptical, and are joined anteriorly by a small common portion. Each ovary is surrounded by a delicate membrane, which, according to Kraemer, passes into the sheath of the oviduct. The ovary is usually so full of eggs that their shape is changed by compression from spherical to polygonal. They will be described later in connection with the life-history.

Text-figure 4.

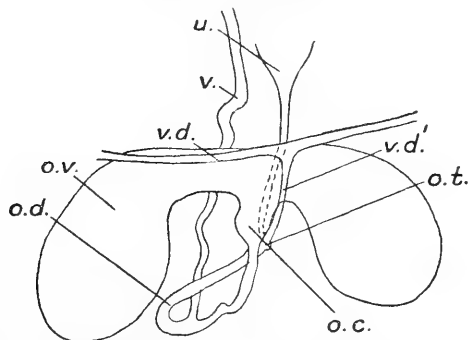


Diagram of the female genital ducts. *o.c.*, oöclapt; *o.d.*, oviduct; *o.t.*, oötype; *o.v.*, ovary; *v.*, vagina; *v.d.*, vitelline duct; *v.d'*, common vitelline duct; *u.*, uterus.

Leading from the connecting-bridge of the ovaries is the oöclapt or "Schluckapparat" (Pl. II. fig. 14). This is a nearly spherical muscular organ, $\cdot 002$ mm. broad $\times \cdot 0022$ mm. long, with a lumen of $\cdot 008$ mm. dia. Its cavity is lined by cubical epithelium according to Benedict, but with simple cuticle according to Kraemer; the latter is the case with my specimens. The muscular band surrounding it is hemispherical in transverse section and constitutes the greater part of its walls. An irregular ring of nuclei surrounds it externally.

Into the oöclapt opens the oviduct. This is a short tube

going to the posterior margin of the proglottis, where it is joined by the vagina, and then, bending at an angle of 30° , it runs anteriorly to open into the oötype just under the oöclapt. Its wall consists of an outer epithelium, a muscular layer, and a thick layer of ciliated cubical epithelium, the wall being $\cdot 0034$ mm. in thickness, surrounding a lumen $\cdot 009$ mm. dia. At its opening into the oötype the lumen of the oviduct decreases to $\cdot 003$ mm. dia.

Benedict states that gland-cells are scattered along the external epithelium, but I have been unable to see them.

The oötype (Pl. I. fig. 11) is a rounded body, $\cdot 014$ mm. dia., with walls $\cdot 0029$ mm. thick, composed of an inner non-ciliated epithelium, a circular muscular layer, and an outer epithelium; round it are scattered nuclei, $\cdot 0011$ mm. dia., not arranged in definite rows as Kraemer states. Surrounding the oötype and opening into it by fine ducts are shell-glands of irregular shape and with definite nuclei. Benedict represents the oötype as an elongated tube between the opening of the common vitelline duct and the uterus: in the position mentioned there is certainly a duct which appears, as he says, like a specialised portion of the oviduct, but this is not the oötype.

The vitellaria consist of small follicles scattered along the whole length of the lateral margins of the proglottis. The follicles are $\cdot 0092 \times \cdot 0069$ mm. in transverse section, with a distinct nucleus, $\cdot 0034$ mm. dia., and are grouped together in fours or fives, each group being enclosed in a membranous sac $\cdot 03$ mm. dia. Two longitudinal ducts, one on each side, run down the proglottis, receiving numerous fine ducts from the sacs, to its hinder end, where they turn inward and join to form a common duct. This duct runs longitudinally for a short distance to open into the oötype. It has a lumen $\cdot 0029$ mm. dia., with walls $\cdot 0023$ mm. thick, consisting of inner and outer epithelia surrounding a well-developed circular muscular coat: connective tissue nuclei form a definite layer round it.

The uterus passes as a narrow tube from the oötype under the connecting portion of the ovaries, and expands as a large sheet with 6-10 lateral outgrowths along the ventral surface of the proglottis (Pl. I. fig. 8). In older segments, the uterus fills the entire segment to the exclusion of all other organs. The ova escape through a cleft in the mid-ventral line.

LIFE-HISTORY.

Historical.

The life-history of this species is unknown. Von Siebold (24) states "*le Tænia longicollis* et le *T. ocellata* qu'on rencontre enkystés, hors du canal intestinal, dans la foie de divers Salmones et Percoides:" the fish are swallowed by pike or perch, in the intestine of which the parasite becomes adult. In

another work (23) he announced definitely that the larval forms of *T. longicollis* and *T. ocellata* occur encysted, with non-mature unsegmented bodies, in the livers of salmon and perch.

Zschokke (26) found the unsegmented larva of *T. longicollis* in *Salmo umbra*.

Similarly, von Linstow (14) states, "Die Larva findet sich encystiert in der Leber desselben Fische, welche die erwachsene Tänie in ihrem Darm beherbergen."

Lühe (17) also inclines to this view. "Als zugehörige Larve ist eine in der Leber von Perciden encystiert gefundene Cestoden-Larva betrachtet werden (?)."

"Leuckart (13) reports a plerocercus found by Gruber in *Cyclops serratulus* which he believed to be the larva of *Proteocephalus torulosa* Batsch. From a comparison of his figure, which is drawn to scale, with measurements of *P. torulosa*, it seems that there is some foundation for this view" (La Rue (12)). To this larval host Lühe (17) adds *C. strenuus*.

It may be seen from the above summary that no accurate experiments have been made with this genus. Most of the investigators incline to the view that the larvæ occur in the same host as the adult form, basing their opinion upon comparisons of the size and general shape of both forms. The connection is thus very loose. The infection would have to be by means of eggs. As there is no swimming-mantle, these do not float, but sink to the bottom; and since the sticklebacks in Edgbaston Reservoir feed chiefly upon Entomostraca, the comparative rarity with which they would swallow eggs could not account for the heavy infection observed. Moreover, the onchosphere would have to bore its way through the walls of the alimentary canal to the liver, encyst there, and then return to the alimentary canal again; for there could be no other way for it to infect both the liver and the intestine of the same host. This hypothesis is not very plausible and is not very well supported. At different times I have examined the livers of sticklebacks but without finding any trace of cysts, although nearly all the stages have been found in the alimentary canal.

My own researches point to the conclusion that an intermediate host, *Cyclops varius* Lillj., is necessary for the full development of the egg, and it is through the final host swallowing the intermediate host, that the parasite obtains entrance to the alimentary canal of the former. This view is supported by the discovery of the plerocercoid of *P. torulosa*, previously mentioned*.

Infection Experiments.

In studying the life-history of this parasite, I first began with the eggs. If the Cestode be adult or nearly so, directly it is removed from the intestine of its host, it begins to discharge the eggs in a continuous stream from a slit in the ventral body-wall.

* See Note on pp. 137-138.

These were pipetted into a small watch-glass, water (pond or tap) was added, and they were examined every day for about two months. It was assumed that water would be the natural medium for their development, since under ordinary circumstances they would be expelled into the pond and wait there until swallowed by their first host. Altogether 20 cultures were thus made and kept from the middle of October until the end of January, but with no results. The most advanced stage was that shown in Pl. III. fig. 23, but this was also observed in eggs taken freshly from a living specimen. Cultures were also made in salt solution, peptone, albumen, and faecal matter, different strengths being used, but with no result.

While these cultures were going on, examples of the most common invertebrates in the reservoir (various species of *Cyclops*, *Cypris*, *Nais*, and *Tubifex*, together with some unidentified Entomostraca and numbers of aquatic insect larvæ) were collected. They were placed in small dishes, each species being kept separately and in definite numbers. A certain amount of Diatoms, *Euglenæ*, Algæ, etc., was placed in each dish for food, together with a large quantity of eggs. No results were obtained until Jan. 7th, when, after examining a *Cyclops*, the cover-glass accidentally crushed it; on re-examining it, several tapeworm eggs were seen in the crushed-out body-mass. All the cultures were then, and for some days afterwards, minutely re-examined, but eggs were only seen in the *Cyclops*.

A fresh series of cultures was made with *Cyclops* from three localities to test this result, with a control to each culture. As was expected, the controls only gave negative results. The other cultures turned out better than was expected (see Table C): as many as 17 out of 20 *Cyclops* in one case were infected, while there were some infected *Cyclops* in every culture. The figures do not represent the whole truth, however. It is extremely difficult to keep the *Cyclops* alive under these artificial conditions; in one culture 4 out of 15 died in one week, in another 2 out of 6, in another 3 out of 7, etc.

Schneider (22) found that in his infection experiments, feeding *Gammarus locusta* with eggs of a species of *Proteocephalus*, the *Gammarus* died in large numbers owing to too heavy infection: this may account for the death of some of the *Cyclops*, since as many as six larvæ in one specimen have often been seen. As it is impossible to distinguish onchospheres in dead *Cyclops*, those dead cannot be counted. (In parenthesis, it may be said that the eggs appear to secrete a toxin which acts injuriously on other animals in the small culture dishes, but which, in the large volume of water in the reservoir, would be diluted until it would become negligible. In one instance a culture was started in a dish containing 20 *Cypris*, some *Euglenæ* for food, and some of the Cestode eggs; a control of the same number of *Cypris* was placed under identically the same conditions, except that the eggs were absent. In 18 days all the *Cypris* in the first culture were dead; in the control I counted 220 living

TABLE C.

Culture.	No. of Cyclops.	Locality.	Number Infected each time.																Total No. Infected.
			January.								February.								
			10	15	16	18	20	22	23	27	28	3	4	7	10	11	20	27	
1 X C.	13	Edgbaston.	S	4	1	5
1 Y C.	20	"	S	4	1	...	2	...	...	3	...	2	...	...	...	...	...	12
*2 Y C.	8	"	S	2	...	...	...	...	...	...	...	...	...	...	...	...	...	2
1 Z C.	10	Wolverhampton.	...	...	...	S	1	...	...	3	...	...	...	2	...	...	...	6
2 X C.	20	King's Norton.	...	...	...	...	...	S	...	...	S	11	...	1	3 added	...	1	13
3 X C.	20	"	...	...	...	...	...	S	...	...	S	3	...	2	...	...	1	6
3 Y C.	20	Edgbaston.	...	...	...	...	...	S	...	...	S	17	...	...	...	...	...	17
2 Z C.	20	King's Norton.	...	...	...	...	...	...	S	...	...	1	...	2	...	...	...	3
	134	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	64

Percentage infected 47.

* Cestode eggs not mature.

S=started.

Cypris. In all cases the animals in the control lived longer than those in the experimental dishes.) Moreover, no attempt was made to discriminate between the different species of *Cyclops*, since the species infected was not known. Under the most favourable conditions it is extremely difficult to see the eggs in the host, so that, owing to the opacity of the body and the development of the dense black ovaries, many probable cases of infection have been overlooked. The results were therefore as good as might be expected.

The intermediate host is therefore a species of *Cyclops*, which Professor G. S. Brady has kindly identified for me as *C. varius* Lilljeborg.

In this connection it may be said that the younger *Cyclops* appear to be more easily and more heavily infected than the adults; the nauplii, however, are never infected.

In addition to these culture experiments, large numbers of Entomostraca, Oligochaeta, and aquatic insect larvæ from the reservoir have been examined at various times. In the winter and early spring no traces of infection were found, although it is quite possible that they may have been overlooked. In June, however, out of 117 *Cyclops* taken at random, 8 were found to be infected, and 3 out of the 8 contained larvæ ready to be transferred to the stickleback. This agrees with Kraemer's (10) statement that the life-history takes place in the summer months, and with the fact that the percentage of adult *Ichthyotæniæ* is greatest at that season. The small percentage of infected *Cyclops* found can be easily explained by the fact that the 117 specimens examined contained examples of many species, but out of these only *C. varius* could be infected. By examining the contents of the alimentary canal of the stickleback, it was ascertained that in summer they fed chiefly upon Entomostraca, so that a very small percentage of infected *Cyclops* would be sufficient to ensure a heavy infection of sticklebacks. It would thus be quite easy to overlook this occasional infection unless one were very familiar with the appearance of the larvæ.

In order to complete the life-cycle of the parasite, an experiment was started to infect the stickleback. This was a failure. A number of sticklebacks were obtained from the same pond, and about 20 were dissected: not one of them showed any trace of the parasite. Ten of them were then isolated and fed occasionally with chopped-up earthworms and infected *Cyclops*; a control experiment was started under the same conditions, except that only earthworms were used for food. The experiment lasted from April 25th to May 16th. From time to time some fish died, but no trace of the Cestode was found in either those from the experimental jar or those from the control. On May 7th, for the first time, a small unsegmented *Ichthyotænia* was found in the intestine of a dead fish; it was obviously in an exceedingly young stage. On May 16th the rest of the fish were dissected, but without finding any Cestodes.

The failure of this experiment was probably due to the small number of *Cyclops* with which the fish were fed (owing to various causes it was difficult to get infected *Cyclops* at the time), the short time between the feeding of the fish and their dissection, and the small size of the larvæ.

The experiment was then repeated, particular attention being paid to the above points, and this time there was success. It began on May 27th, when 11 sticklebacks from the same pond were fed with about 20 infected *Cyclops*. The following results were obtained :—

DATE.	Number Dead.*	Larvæ in each.	Number Infected.
June 4th.....	4	0, 4, 7, 1	3
„ 6th.....	3	0, 0, 4	1
„ 7th.....	1	2	1
„ 30th.....	1	1	1
July 1st	2	8, 1	2
	11	28	8

A control experiment of five sticklebacks was started at the same time and gave a negative result.

In order to test the possibility of direct development, an experiment was started on June 12th. Nine sticklebacks were isolated and fed with large quantities of adult proglottides of the Cestode; in addition, a large number of eggs was put into the water. The experiment lasted until July 16th, when the surviving sticklebacks were dissected. None of the nine, however, showed the slightest trace of infection, either in the liver or in the intestine.

As a further test, thirteen sticklebacks from the reservoir were isolated and kept for about six weeks. They were then dissected, but the only trace of infection found was a nearly adult cestode in the intestine of one of them. It is practically certain, considering the heavy percentage of infection, that at least half these were infected at first; the worms must therefore have been ejected and have shed their eggs into the water. If direct infection occur, then the sticklebacks should have been re-infected, but since no infection was found, the conclusion is that direct infection does not take place. La Rue (11), in attempting to show direct development in *P. filaroides* from the salamander, failed to infect the salamander itself with eggs of the Cestode, although in his case the conditions were certainly not very favourable.

* Both in this, and in the following experiments, a fungus (*Saprolegnia ferox*) obtained entrance to the experimental jar and killed the fish, so that the adult Cestode could not be bred.

Development.

The development of the egg has not been fully worked out, but the results so far show a close similarity to those of van Beneden (2), who used *Taenia serrata*.

Both fresh and stained material have been used; the results obtained by the use of the former give a connected series, but there are gaps between the stages observed in stained material.

Kraemer (10) appears to be the only investigator who has described the several stages in the development of the egg, but my own material does not agree at all with his description.

The following results were obtained from fresh unstained material.

When the eggs pass into the uterus, they appear to consist of a transparent colourless membrane, $\cdot 021$ mm. dia., containing a roughly spherical mass of uniform refractive grey yolk-granules; this inner mass lies freely within the membrane, which only touches it at one or two points. Both the membrane and the inner mass increase in size, but the former more rapidly than the latter, so that later on, the impression given is that of a grey ball, $\cdot 025$ mm. dia., within a large bubble $\cdot 047$ mm. dia. (Pl. II. fig. 15). From this point the membrane always preserves the same relative distance between it and the inner mass, and finally becomes the outer membrane of the onchosphere (*m.*). The yolk-follicles now begin to disappear, clustering together at one pole, the remainder of the inner mass being filled up by a fine grey granular substance, from which the onchospheric hooks appear to originate.

Meanwhile the inner mass has become differentiated into a central mass, $\cdot 023$ mm. dia.—the future onchosphere—within an outer granular coat, $\cdot 028$ mm. dia. and $\cdot 002$ mm. thick (Pl. II. fig. 17), which at first touches it at every point, but later shrinks away to leave the onchosphere entirely free. By the time the yolk-follicles have disappeared the egg has become ready for discharging (Pl. II. fig. 19). It then consists of the onchosphere, $\cdot 023$ mm. dia., provided with six hooks, and closely surrounded by a delicate membrane. This is surrounded by the granular second membrane (*m'*.), $\cdot 035$ mm. dia. and $\cdot 002$ mm. thick, the whole free within a transparent membrane (*m.*), $\cdot 058$ mm. dia. The hooks are $\cdot 011$ mm. long, $\cdot 001$ mm. at their broadest part, and the curved part is $\cdot 004$ mm. long. Treatment with a solution of methyl green in 1 per cent. acetic acid shows that the second membrane has a circular hole, $\cdot 0057$ mm. dia., in it.

Sections of the cestode killed with Petrunkevitch's solution and stained with iron hæmatoxylin give the best detailed results.

The ovarian eggs (Pl. III. fig. 24) are $\cdot 017$ mm. dia., very granular, and are surrounded by a distinct membrane. A clear nucleus, $\cdot 0092$ – $\cdot 0103$ mm. dia., is present, containing a dark-

staining nucleolus, .0057-.0069 mm. dia.; often granular strands connect the nucleolus to the nuclear membrane. In addition, there is a dark-staining "Nebenkörper" or "corps lenticulaire" of irregular shape and indefinite size. It seems to disappear before the first division and is of unknown significance. Von Linstow (14) has figured a similar body in the eggs of *Tenia longicollis* Rud.

The first division of the fertilised egg (Pl. III. fig. 25) is into a vitelline cell crowded with yolk-granules and a "Keimzelle," with nucleus and nucleolus. Kraemer for *T. filicollis*, and von Linstow for *T. longicollis*, figure the vitelline globules as isolated, not as being contained in a single cell.

The "Keimzelle" next divides into two, and each of these into two again, four cells of equal size being formed (Pl. III. fig. 29), .012 mm. dia., with nuclei .005 mm. dia. In van Beneden's account, these cells are of unequal sizes, two large macromeres forming the "couche albumineuse," and two small micromeres forming the onchosphere with its membranes and hooks. In this case there is certainly a "couche albumineuse" formed (Pl. III. fig. 31), although as the four cells are identical, it is impossible to distinguish those from which it arises. The remaining cells divide repeatedly, forming a cellular mass, the nuclei of which are of two sizes:—

- (1) nucleus .0057-.0069 mm. dia., nucleolus .0023-.0034 mm. dia.
- (2) " .004-.0046 " " " .0011 mm. dia.

The cells containing the larger nuclei surround the others and a split appears between the two (Pl. III. fig. 30). This gradually widens until the first cells form a definite coat—the second onchospheric membrane—round the smaller ones (Pl. III. fig. 32). It is thus probable that the former correspond to van Beneden's "Chitinogenzellen." The origin of the hooks and the third onchospheric membrane I have not been able to discover.

The vitelline cell, produced by the division of the ovarian egg, does not exist long as a distinct cell, and soon degenerates into a mass of yolk-follicles. It is these follicles which scatter when the onchosphere breaks through the second membrane (Pl. III. fig. 23).

At the time of discharge, the onchosphere is formed of a number of spherical cells, .0057 mm. dia., with distinct nuclei, .0034 mm. dia., the cells at the posterior end being slightly larger than those at the anterior.

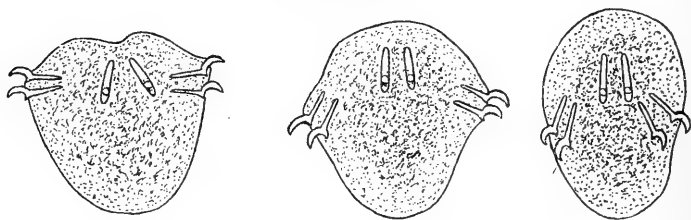
When the contents of the majority of the proglottides are ready for discharging, the Cestode slightly migrates through the intestine, probably by the contractions of the latter, and hangs out of the anus. The eggs are then expelled from the uterus through a slit caused by a rupture of the ventral body-wall. When the contents of the exposed proglottides have been discharged, the body hangs further out, exposing more segments, until all the ripe eggs have been extruded. If stickle-

backs infected by this parasite be kept in an aquarium, it is no uncommon sight to see them with $5''-2''$ of cestode hanging out of the anus. The proglottides first emptied degenerate, and all traces of segmentation become obliterated, until by the time the last eggs are discharged, the distal end has become an unrecognisable shapeless mass. The whole cestode is then discharged with the faeces, and this is often followed by the death of the fish.

Some time after entering the water, the onchosphere escapes through the hole in the second membrane to lie freely inside the outer one. Since the diameter of the hole is less than that of the onchosphere, the latter is considerably contracted in its passage: the third membrane is often dragged out with it, but it may be ruptured and left behind. The cause of this escape may be possibly due to osmosis, but it is more probable that it is due to the onchospheric movements about to be described. The posterior portion of the onchosphere is always under the aperture in the second coat, so that the movements would have a ramming effect upon the delicate third membrane, and either rupture it or drag it out. The pressure of the coverslip is not the cause, for I have often seen similar movements in onchospheres lying freely in a watch-glass. Yolk-follicles are often scattered within the membrane at the time of the escape.

The onchosphere now exhibits curious movements (I have only seen them in the free onchosphere, but it is probable that they occur also before the escape takes place). It slowly contracts

Text-figure 5.



Drawing to show movements of onchosphere.

antero-posteriorly, stretching out its hooks as far as possible; the extreme anterior point often forms a small depression surrounded by a ridge. With a quick jerk it elongates itself along the same line, at the same time striking downwards with its hooks until they lie flat against the body. It then contracts as before. The movements are repeated indefinitely, and are probably for the ultimate purpose of attaching the onchosphere to the alimentary canal of its host.

La Rue (11) reports similar movements in the onchospheres of

P. filaroides. In this case though, the movements of two pairs of hooks alternate with those of a third pair, and the body changes from a spherical to a pear-shaped form. He also saw these movements in onchospheres of *Hymenolepis nana*.

At this stage the onchosphere is swallowed by a *Cyclops*. It appears to pass through the stomach and first portion of the alimentary canal without any change or delay, and although it generally anchors itself to the wall about the junction of the thorax and abdomen, I have seen cases where it has attached itself to the wall of the alimentary canal just within the stomach on the one hand, and just above the anus on the other, but these are not common. After a certain time has elapsed, the extent of which is very variable but is usually a week, it breaks through the wall of the intestine into the dorsal sinus and is swept forward to lie usually near the posterior end of the carapace, but often in the head above the eye; it may also lie under the alimentary canal, but this is rare. Here it becomes very vacuolated at first, but later has a more solid appearance (Pl. IV. fig. 33). The hooks gradually disappear, and the body becomes partially covered with highly refractive granules, either isolated or disposed in clusters. These granules greatly resemble those found on young larvæ in the intestine of the stickleback, except that they are smaller.

At the end of three weeks the larva is ready to be transferred to its second host (Pl. IV. fig. 37). It is an elongated grey body of variable size, and *in situ* seems to be an undeveloped part of the ovary. It is apparently studded with the refractive granules just mentioned, .004 mm. dia., which give it a characteristic appearance when removed from the *Cyclops*. In sections it may be seen that these really occupy spaces in the body parenchyma just under the cuticle and correspond to the calcareous bodies of older forms. There is no scolex and no neck, the body being entirely without divisions. At the anterior end are four suckers, .03 mm. dia., which look like small blisters of the cuticle; they are probably functionless at this period. In sections they are practically level with the rest of the body. They are composed of the same parenchyma as the rest of the body (Pl. IV. fig. 35) only in a more compact form, and have two dark-staining types of cell. The first type is elongated, .005–.007 × .001 mm. It is present only in larvæ in an advanced stage of development, and is probably an embryonal muscle-cell. The other type is the same in size and form as the cells of the parenchyma. In younger cases the suckers appear like the rest of the parenchyma, from which, in transverse sections, they are only separated by a thin line. There is no trace of the fifth sucker. The scolex is not invaginated at any time during the development; it appears as if it were gradually differentiated from the body parenchyma at an early stage.

The whole body is covered by a cuticle, extending also over the suckers and excretory pore (Pl. IV. fig. 36). Its outer layer

is rough and ragged like that of the adult. Under it is a smooth homogeneous layer, .0018–.0029 mm. thick. Owing to the small size of the larva I have been unable to find any definite traces of muscles. Muscles must undoubtedly be present, however, for the larva is capable of sluggish contractions similar to those of the adult.

The body within the cuticle is a nearly solid mass of parenchyma. Just inside the cuticle the parenchyma forms a fairly compact sheath, but in proportion to its distance from the exterior it loses this compactness and becomes vacuolated, the centre itself being a fairly loose meshwork like that of the adult. The parenchyma between the suckers is firmer than that elsewhere. The parenchyma itself is a faintly staining granular mass, forming a more or less definite meshwork through which dark-staining cells are scattered (Pl. IV. fig. 35). It is not probable that these are nuclei owing to their comparatively large size, .003–.005 mm. dia.; inside them are often several darker staining bodies. In addition to these are smaller bodies like the former only smaller, .0016–.0025 mm.; they are also present in young suckers, and may possibly be nuclei. Occasionally circular granular bodies, .004 mm. dia., not so deeply staining as the others, are to be seen. These I take to be the refractive granules (calcareous bodies) apparently present on the surface of the larva. Running in all directions through the parenchyma are delicate fibres, which may possibly be the rudiments of muscles. It is exceedingly difficult to state the histological significance of all these different structures owing to their small size and general indefiniteness.

At the posterior end of the larva is a small depression running .016 mm. into the body, its apex expanding into an oval chamber, with its long axis parallel to that of the larva (Pl. IV. fig. 36). On all sides but one, this invagination is enclosed by the body, but on the fourth side it appears to be open to the exterior; if seen from this side, it shows the entire depression—in shape like the gullet and buccal groove of *Paramæcium*—which is not visible from the other side (Pl. IV. figs. 39, 40). The cuticle covers its exterior, so that it is a true invagination. Presumably this corresponds to the heart-shaped bubble in which, according to Kraemer, the longitudinal excretory canals open. I have been unable to see any signs of excretory organs, however.

There are no traces of reproductive organs in such a young stage.

The presence of the larva is fatal to the *Cyclops*, apparently causing its starvation. The orange globules usually present in the head of the *Cyclops* vanish, and the ovary degenerates and dwindles to half its usual size. The activity of the *Cyclops* also suffers; it does not swim so rapidly and takes much more frequent and longer rests than its fellows. Ultimately it dies. This sluggishness and death would be favourable to the larva, for

it would result in the easier capture of the *Cyclops* by the stickleback, and thus ensure the larva a better chance of attaining maturity.

The *Cyclops* is swallowed by the stickleback, and in the intestine of the latter the larva is set free to grow into the normal adult.

SUMMARY.

1. The paper contains a description of a tapeworm parasitic in *Gasterosteus aculeatus* Artedi. I regard this tapeworm as *Ichthyotenidia filicollis* Rud., though the absence of an adequate description of the species and the confusion into which the nomenclature has fallen, make the identification a matter of considerable difficulty. The synonym, *Proteocephalus* Wein., used by La Rue (12), does not seem to me justifiable.

2. An account is given of the anatomy and histology of the species. With the exception of one or two details, this account agrees closely with that given by Benedict (3) and by Kraemer (10).

3. Though many conjectures have been made with regard to the life-history of *I. filicollis*, no reliable information has hitherto been published. The evidence given in this paper shows that *Cyclops varius* Lillj. is the intermediate host. This conclusion is based upon successful experiments to infect the *Cyclops* by the tapeworm egg, and to infect the stickleback by the larva in the *Cyclops*. Direct infection of the stickleback proved impossible.

4. A short account is given of the segmentation of the egg and the development of the larva. Though incomplete in some respects, it was found that it followed the general course described by van Beneden (2).

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EXPLANATION OF THE PLATES.

PLATE I.

- Figs. 1-7. Series of scoleces, showing variation in shape and size. Fig. 3 is the normal form. $\times 125$.
 Fig. 8. Optical section of a proglottis. *c.s.*, cirrus-sac; *g.s.*, genital sinus; *l.c.*, longitudinal excretory canal; *ov.*, ovary; *v.*, vagina; *vas.*, vas deferens; *vit.*, vitellaria; *u.*, uterus. $\times 185$.
 9. Longitudinal section of cirrus-sac. *c.m.*, circular muscles; *ew.*, outer, and *iw.*, inner wall of cirrus-sac; *l.m.*, longitudinal muscles; *r.m.*, retractor muscles; *vas.*, vas deferens. $\times 590$.
 10. Transverse section of cirrus-sac, lettering as above. *c.g.*, gland. $\times 870$.
 11. Longitudinal section of oötype. *o.d.*, oviduct; *O.T.*, oötype; *Sh.G.*, shell gland; *u.*, specialised part of uterus. $\times 870$.

PLATE II.

- Fig. 12. Longitudinal vertical section through cuticle. *c.*, *c'*, outer and inner layers of cuticle; *c.c.m.*, circular, *c.l.m.*, longitudinal cuticular muscles; *i.l.m.*, inner longitudinal muscles; *i.s.*, intercellular space; *p.c.*, cell of parenchyma; *s.c.*, cell of sub-cuticula. $\times 600$.
 13. Longitudinal section through vaginal aperture. *s.m.*, sphincter muscle; *v.e.*, vaginal epithelium; *v.g.*, vaginal gland; *v.m.*, vaginal muscle. $\times 870$.
 14. Longitudinal section through oöclapt. *c.e.*, cubical epithelium of oviduct; *o.e.*, outer oviducal epithelium; *o.m.*, oviducal muscle; *ov.*, ovary; *ov.b.*, connecting part of ovaries; *s.a.*, muscle of oöclapt. $\times 870$.
 Figs. 15-19. Stages in the development of the egg. *m.*, first, *m'*, second onchospheric membrane; *o.*, onchosphere; *o.h.*, onchospheric hooks; *a.*, aperture in second egg-membrane; *y.*, yolk-follicles. $\times 870$.

PLATE III.

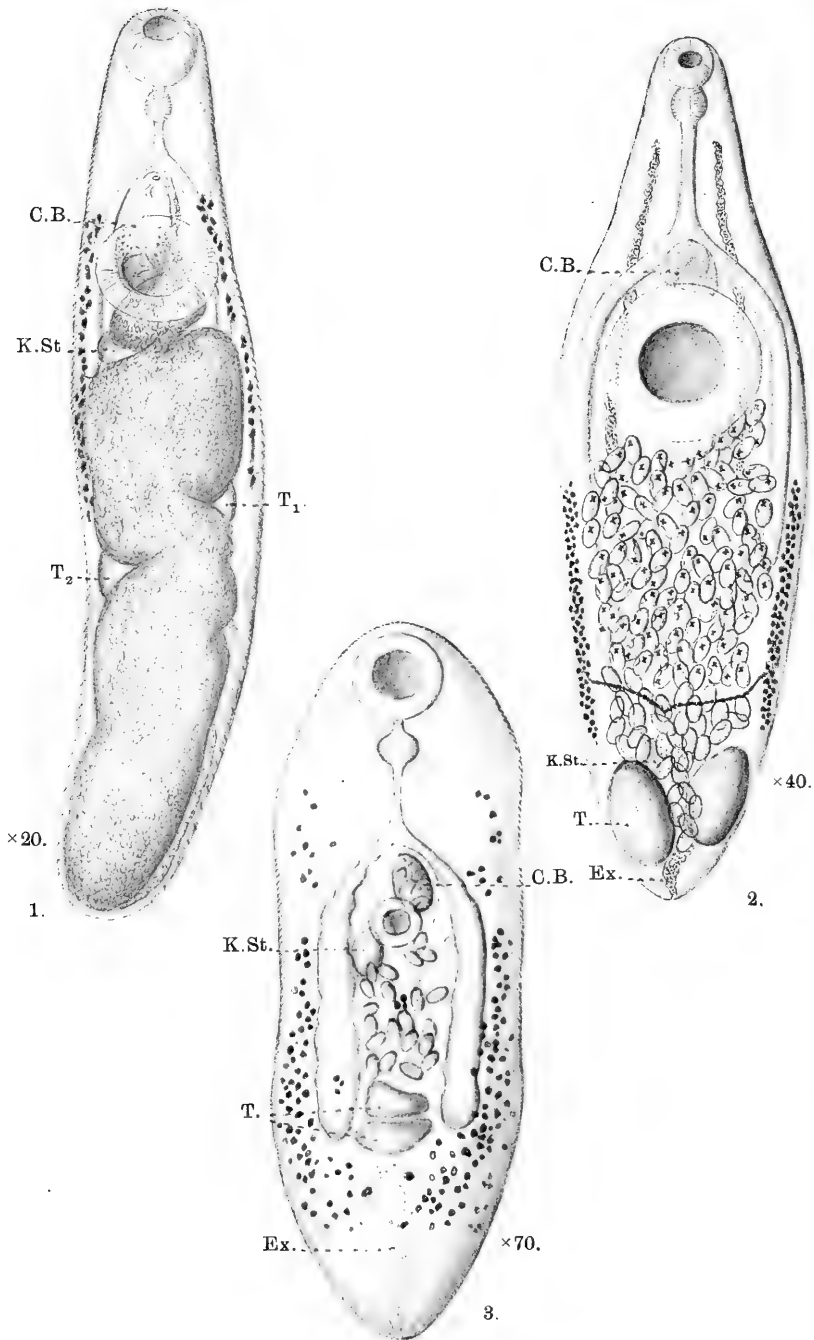
- Figs. 20-22. Stages in the rupture of the second onchospheric membrane. $\times 870$.
 Fig. 23. Onchosphere after rupture of second membrane. *m.*, *m'*, *m''*, first, second, and third onchospheric membranes. $\times 870$.
 24. Eggs from ovary. *e.g.*, Egg membrane; *n.*, nucleus; *n'*, nucleolus; *n.k.*, "Nebenkörper." $\times 870$.
 25. First division of egg. *k.m.*, "Keimzelle"; *m.*, first onchospheric membrane; *n.*, nucleus; *n'*, nucleolus; *v.c.*, vitelline cell. $\times 970$.
 26. Later stage, showing division of "Keimzelle" nucleus. $\times 970$.
 27. Stained section of fig. 26. $\times 870$.
 28. Section of three-cell stage. $\times 870$.
 29. Four-cell stage. Only three of the four products of "Keimzelle" division are shown. *v.c.*, vitelline cell. $\times 870$.
 30. Section of older egg. *ch.*, "Chitinogenzellen"; *o.*, onchosphere; *sp.*, split between the two; *v.c.*, vitelline follicles. $\times 870$.
 31. Older egg. *c.a.*, "couche albumineuse."
 32. Section of uterine egg. $\times 870$.

PLATE IV.

- Fig. 33. *Cyclops varius*, containing young larvæ. *l.*, larvæ. $\times 50$.
 34. Transverse section of the *Cyclops*. $\times 142$.
 35. Longitudinal section through head of a larva from *Cyclops*. *c.*, *c'*, outer and inner layers of cuticle; *m.*, *m'*, the two types of parenchymatous cell; *o.g.*, space containing calcareous body; *s.*, sucker. $\times 870$.
 36. Longitudinal section through posterior end of larva. *e.p.*, excretory pore. $\times 830$.
 37. Larva from *Cyclops varius*. *s.*, sucker; *c.b.*, calcareous body. $\times 155$.
 38. Larva from an artificially infected stickleback. $\times 95$.
 39. Young larva from a stickleback. $\times 95$.
 40. Older larva. $\times 95$.

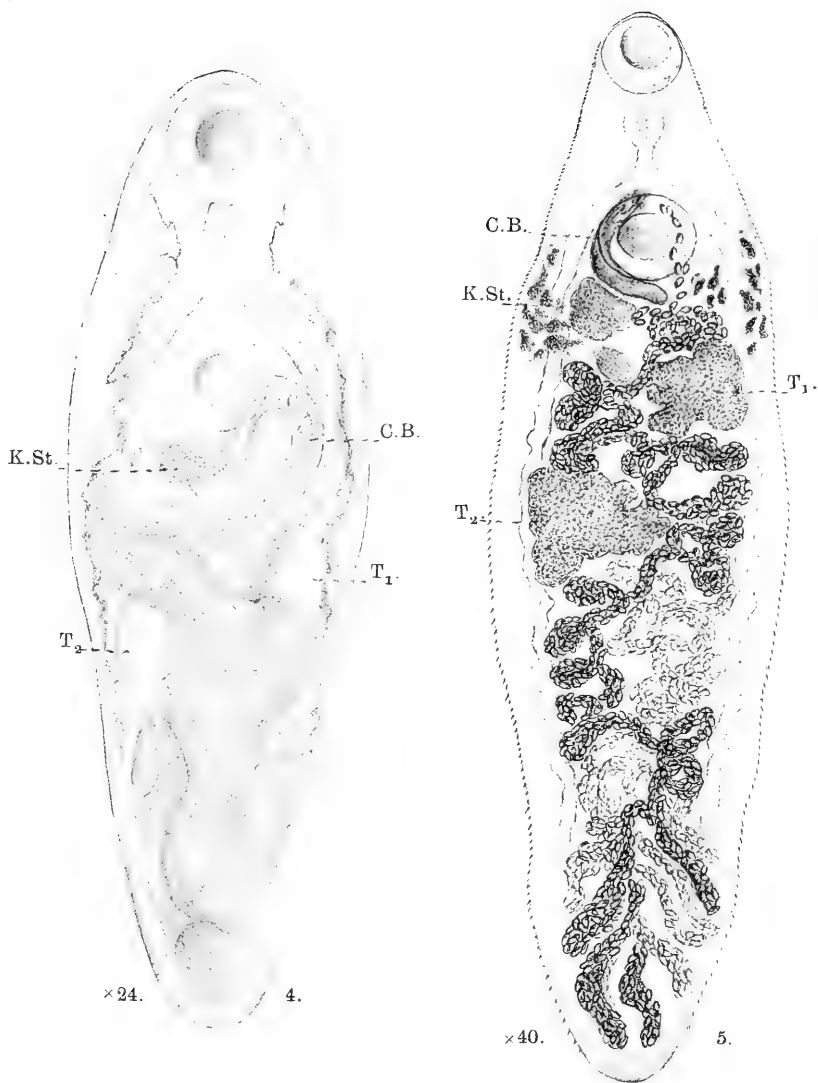
[NOTE.—Since sending in this paper, I have been able to obtain a copy of Barbieri's memoir (Central. f. Bakt. u. Paras., Abt. i.

1909, Bd. xlix.), in which he records a cyst of *I. agonis* from the mandible of *Bythotrephes*; Fuhrmann also records from *Planaria lactea* a plerocercoid which he regards as that of a species of *Ichthyotænia*. These cases further strengthen the assumption that an intermediate host is necessary for the development of all species of *Ichthyotænia*.]



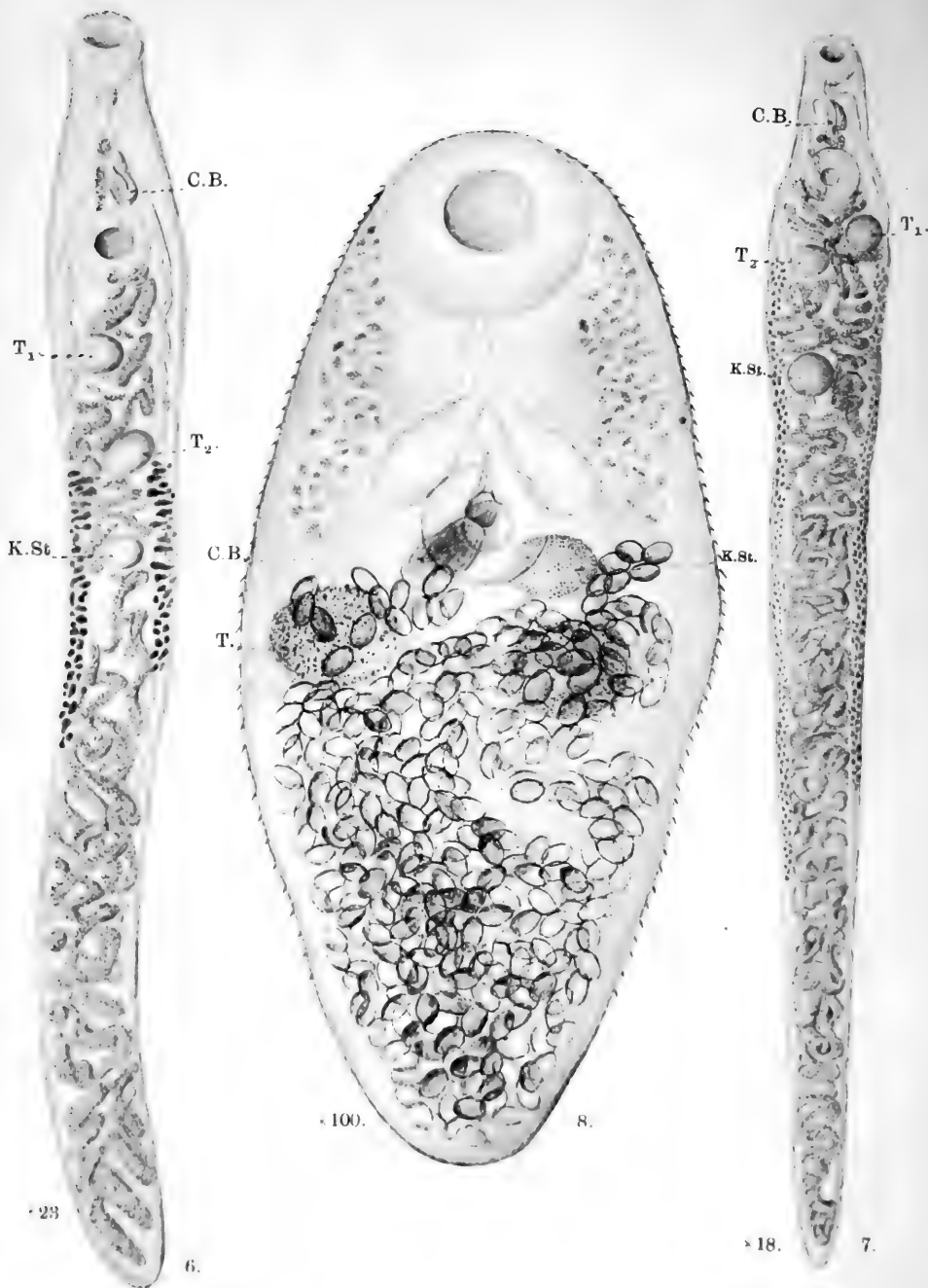
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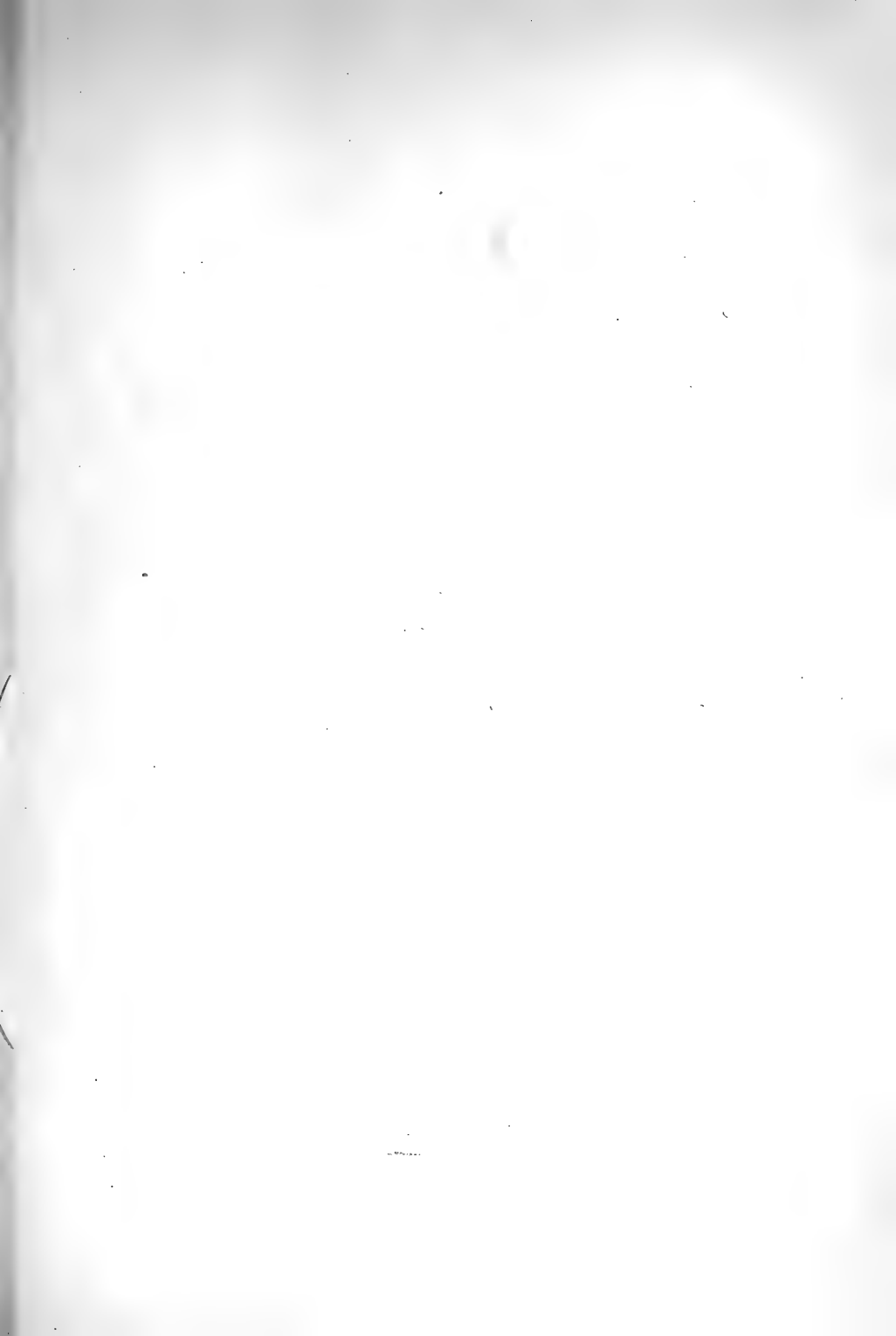
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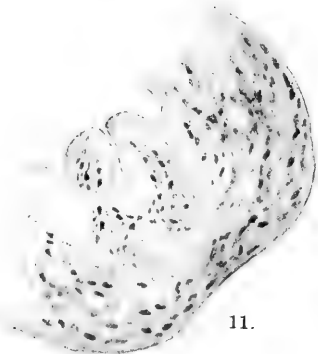
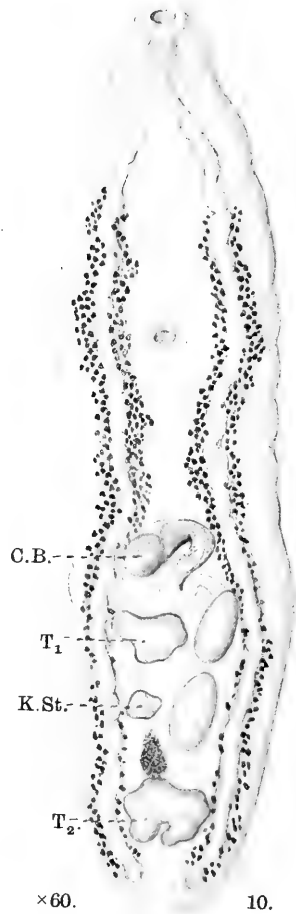
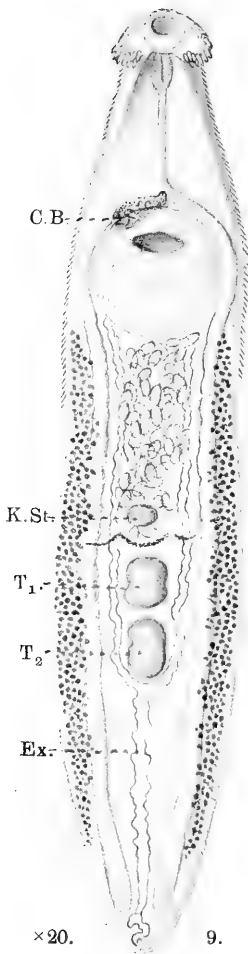
TREMATODE PARASITES.



M Rhodes and G. Roberts, del.

TREMATODE PARASITES.





9. Trematode Parasites from Animals dying in the
Zoological Society's Gardens during 1911-1912. By
WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S.

[Received November 3, 1913 : Read March 3, 1914.]

(Plates I.-IV.)*

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During the course of 1911 and 1912 opportunity was afforded me of making a fairly complete examination of the viscera of many of the animals dying in the Gardens. For this I have

* For explanation of the Plates see pp. 153-154.

to thank the courtesy of the Secretary and the officials at the Prosectorium. The animals were almost exclusively birds and reptiles or batrachians; no fishes, and only a few mammals were examined. The collection yielded between twenty and thirty species, a considerable proportion of which are new. Some of these have already been described in previous communications to the Society (Nicoll, 1911, 1912, *a*, *b*).

The reptilian parasites were the most interesting of those obtained, as several of them represented new generic types. They include forms from the Striped Snake, the Spiny-tailed Mastigure, Schott's Tree-Snake, and Smyth's Water-Snake.

Usually there was an interval of twenty-four hours, sometimes longer, between the death of the animal and the time of examination, but in spite of that the parasites in most cases were in a good state of preservation. In some instances, however, they were so macerated as to be almost useless. As might have been expected, parasites were more frequent in those animals which had been in the Gardens for the shortest period. Except in the few instances reported by Dr. Leiper (1912), there appears to be little probability of infection being acquired in the Gardens. In most cases the infections were not heavy, there being usually only a few worms present. Gross infections, however, were met with in the case of some Striped Snakes which were heavily infected with two larval Trematodes (Nicoll, 1912), and a Marsh Harrier which contained a large number of liver-flukes.

The first form I shall describe is an interesting new species from the Striped Snake (*Tropidonotus ordinatus*).

Family LEPODERMATIDÆ.

1. MEDIORIMA PROPRIA, gen. et sp. n. (Pl. I. fig. 1.)

This species is a typical member of the family Lepodermatidæ, to which a large proportion of reptilian trematodes belong. One specimen was obtained from the intestine of a Striped Snake (*Tropidonotus ordinatus*).

It is an elongated, slightly flattened Trematode, both ends of which are rounded. The cuticle is beset with small spines, which extend throughout the whole length of the body. The length is about 6 mm., the greatest breadth, near the middle of the body, is 1.2 mm.

The globular oral sucker has a diameter of .5 mm.; the ventral sucker, which is somewhat oval, measures .7 × .8 mm., and is situated 1.7 mm. from the anterior end.

There is a very short prepharynx, and a pharynx measuring .2 × .17 mm. The œsophagus is about the same length as the pharynx. The intestinal diverticula are short, not extending very far (.4 mm.) beyond the ventral sucker. Their ends are obscured by the enormous mass of ova.

The genital aperture is median and is situated just behind the

intestinal bifurcation. The cirrus-pouch is short and stout, measuring $.8 \times .34$ mm. It is almost oval in outline. Within it there is a small convoluted vesicula seminalis, with a moderately long pars prostatica and a short ductus ejaculatorius. The vagina is somewhat shorter than the cirrus-pouch.

The small globular ovary is situated a short distance behind the ventral sucker on the right side and is largely concealed by the uterus. The anterior testis lies on the left about 1 mm. behind the ventral sucker, while the posterior testis lies a little further back on the right side. Both are almost entirely concealed by the uterus, so that their size and shape could not be determined. They are, however, apparently elongated oval in outline. The yolk-glands are scanty, consisting on each side of a little more than a single row of follicles external to the intestinal diverticula, and extending from midway between the genital aperture and the anterior edge of the ventral sucker to the level of the anterior testis.

The uterus fills up the greater part of the posterior two-thirds of the body. It consists of a narrow descending limb and a very greatly distended ascending limb, which is twisted into slight folds. The extremely numerous ova are dark brown in colour and measure $.039 \times .018-.020$ mm.

This species bears a very close resemblance to the genus *Lechrriorchis*, but is distinguished from it by the position of the genital aperture and the shape of the cirrus-pouch.

2. OMMATOBREPHUS SINGULARIS, gen. et sp. n. (Pl. I. fig. 2.)

A single specimen of this species was obtained from the intestine of the Spiny-tailed Mastigure (*Uromastix acanthinurus*). It presents several features of interest.

The length of the specimen, slightly pressed, is 2.73 mm., and the maximum breadth across the ventral sucker is .8 mm. The anterior part of the body is considerably attenuated, the posterior part is more rounded but terminates in a somewhat acute point. There are no cuticular spines.

The subterminal oral sucker has a diameter of .18 mm. and the ventral sucker measures .53 mm. The latter is situated at a distance of 1.06 mm. from the anterior end. Contiguous with the oral sucker is a large pharynx, measuring $.12 \times .14$ mm. This is followed by a long oesophagus, .31 mm. in length. The intestinal bifurcation takes place a little in front of the ventral sucker, and the short diverticula terminate about midway between the ventral sucker and the testes.

The excretory vesicle is Y-shaped with a short sinuous stem, bifurcating a little in front of the testes, and limbs extending nearly to the level of the pharynx.

The genital aperture is median, just over the intestinal bifurcation. The cirrus-pouch is stout and almost globular, lying almost entirely in front of the ventral sucker. Its length and diameter are about .2 mm. It is thin-walled and contains a thick

highly-convoluted vesicula seminalis with a short prostate and ductus. The testes lie alongside one another, almost at the posterior end of the body. They are slightly asymmetrical, the left being a little in advance of the right, and they are separated by a narrow fold of the uterus. They are elongated oval in outline and measure $\cdot35 \times \cdot22$ mm.

A little in front of the testes lies a small round ovary, somewhat on the right side of the middle line. The shell-gland complex is entirely obscured by the uterus. The yolk-glands are of restricted extent, being confined to the extreme edges of the body and extending only from the ovary to some distance behind the ventral sucker. The uterus fills up the whole of the middle of the body and sends a small loop down between the testes. The eggs are thin-walled and very transparent, and the majority of them contain a fully developed miracidium, the X-shaped eye-spots of which are very conspicuous. The eggs measure $\cdot095 \times \cdot056$ mm.

This form evidently belongs to the family Lepodermatidae, but it is somewhat aberrant. Its most distinctive features are the unusual position of the genital glands and the precocious development of the miracidia, together with the large size of the eggs.

3. OPISTHOGENES INTERROGATIVUS, gen. et sp. n. (Pl. II. fig. 4.)

Five specimens of this parasite were obtained from the intestine of Schott's Snake (*Philodryas schotti*). In length they vary from 4.5 mm. to 6.2 mm. (pressed specimens); the average is 5.4 mm. The greatest breadth across the ventral sucker is 1.7 mm. The outline is almost fusiform, the posterior half being more attenuated than the anterior.

Both suckers are nearly globular, the oral measuring .64 mm. and the ventral .56 mm. In both cases the longitudinal diameter is usually slightly greater than the transverse. The ventral sucker is situated 1.74 mm. from the anterior end. There is a short prepharynx followed by a pharynx measuring $\cdot21 \times \cdot2$ mm. The oesophagus is slightly longer than the pharynx, .27 mm. The intestinal diverticula terminate some distance (about .6 mm.) from the posterior end of the body, but their ends are obscured by the dense mass of the uterus.

The excretory vesicle is long and wide. The median stem runs forward to near the ovary before dividing into the two short lateral branches. The vesicle, as well as the main collecting tubules, are clearly mapped out owing to the pigmented nature of their contents. A large number of fine branches are given off from the vesicle, and these form an anastomosing network throughout the whole body.

The cirrus-pouch has the shape of an interrogation mark, curving over the left posterior quadrant of the ventral sucker. Its proximal end lies a short distance behind the sucker, while the male genital aperture is 1 mm. behind the sucker and a little to the left of the middle line. The female aperture is separated

from the male but immediately behind it. The cirrus-pouch contains a highly convoluted vesicula seminalis, a short pars prostatica, and a long straight ductus and cirrus. The musculature of the pouch and of the cirrus is extremely well developed.

The anterior testis lies on the left side, near the genital aperture. The second testis lies on the other side of the body, and is separated from the first by the uterus. The anterior border of the one is about .2 mm. in front of that of the other. Both are somewhat elongated oval in outline, their long diameter measuring .5-.65 mm. They are moderately thick and are not much overlapped by the uterus.

The ovary lies not far behind the ventral sucker, alongside the proximal end of the cirrus-pouch. It is globular and considerably smaller than the testes. It is usually difficult to see, owing to its being obscured by the uterus. Laurer's canal is present, but there is no receptaculum seminis. The initial part of the uterus is filled with sperms. The yolk-glands have an unusual disposition. Instead of being lateral they are entirely dorsal. Situated in the posterior half of the body, they extend from the level of the genital aperture to a short distance (.4 mm.) behind the testes. They consist of fairly large follicles which lie between the excretory vesicle and the cuticle, and which do not spread to the outer side of the intestinal diverticula.

Starting from the ovary, the uterus forms several small dorsal convolutions on its way towards the posterior end of the body. On turning forward it becomes greatly dilated. At first it runs almost straight forwards, then bends towards the left testis. Passing between the testes it forms a fairly large convolution in front of the right testis. It then passes across the ventral sucker and finally runs down along the left side of the cirrus-pouch. It overlaps the intestinal diverticula to a considerable extent. The vagina is a wide muscular structure about half the length of the cirrus-pouch. The ova are very numerous, dark brown in colour, and measure .020-.023 \times .013-.014 mm.

This species is most closely allied to *Opisthogonimus philodryochus* West, but it appears to present features of sufficient importance to warrant its being regarded as the type of a distinct genus. The chief distinctive features are the position of the genital aperture, the shape and structure of the cirrus-pouch, and the position of the yolk-glands.

4. OPISTHIOGLYPHE ADULESCENS, sp. n. (Pl. I. fig. 3.)

A few specimens of this form were taken from the intestine of an Asp Viper (*Vipera aspis*). They were all obviously immature, and on that account the following can only be regarded as a provisional description. For the same reason it is impossible to be absolutely certain that this form is distinct from the already known species of the genus, but one or two distinctive features seem to point to the fact that it is a separate species.

In shape it is elongated oval with somewhat pointed ends and almost parallel sides. The length is about 1.3 mm. and the greatest breadth .46 mm. The cuticle is beset for at least three-quarters of the length of the body with minute spines. The oral sucker is subterminal and has a diameter of .17 mm. The round ventral sucker is much smaller, measuring only .10 mm., and it is situated at a distance of .55 mm. from the anterior end of the body.

There is a short prepharynx, a pharynx measuring $.06 \times .08$ mm., and a long œsophagus, twice the length of the pharynx. The intestinal diverticula are rather wide, and do not extend more than halfway between the ventral sucker and the posterior end of the body. The excretory vesicle is dilated and the median stem divides a short distance behind the ovary. The paired limbs only extend to the ventral sucker.

The genital aperture lies a short distance behind the intestinal bifurcation. The cirrus-pouch is short and plump, reaching only a short distance behind the anterior border of the ventral sucker. It contains a highly convoluted vesicula seminalis, a short pars prostatica, and a short ductus ejaculatorius. The testes lie at the level of the end of the intestines. They are tandem or slightly oblique, and almost contiguous. They are of very irregular shape, and are always broader than long. Their dimensions are about $.06 \times .13$ mm. The post-testicular space is almost exactly one-quarter of the body-length.

The ovary is contiguous with the ventral sucker on its right posterior border. It also touches the right intestinal diverticulum. Its size is $.08 \times .06$ mm. The yolk-glands are extremely scattered and imperfectly formed. They consist of small, rather isolated follicles extending along the sides of the body from the middle of the œsophagus to the middle of the post-testicular space. In the latter they extend inwards but do not meet in the middle line. They overlap the intestinal diverticula only to a very slight extent. The uterus is confined between the testes and the ventral sucker, and does not overlap the intestinal diverticula. It contains about two dozen eggs, measuring $.042 \times .021$ mm.

It does not appear likely that this can be the young stage of any of the already known species of *Opisthioglyphe*, for it is differentiated from *O. ranae* by the length of the intestinal diverticula and the ratio of the suckers. The configuration of the excretory vesicle is also different. From *O. hystrix* it differs in the position of the ventral sucker, the length of the intestinal diverticula and of the cirrus-pouch, and the extent of the yolk-glands. It also differs in several important particulars from the more recently described *O. locellus* Kossack. I am unable to compare it with *O. siredonis*, as Poirier's paper is not available.

5. STYPHLODORA PERSIMILIS, sp. n. (Pl. II. fig. 5.)

About thirty specimens of this parasite were removed from the ureters of an Indian River-Snake (*Tropidonotus piscator*)

which died in the Gardens on December 4th, 1911. Owing to its extreme resemblance to *S. serrata* Lss. and *S. horrida* (Leidy), I have had considerable hesitation in deciding to regard it as a new species. Coming, however, from such different hosts as the Egyptian Monitor (*Varanus niloticus*), *Boa constrictor*, and the present host, and from such widely separated parts of the world as Egypt, North America, and India, the probability is that they represent three distinct species. It also bears some resemblance to *S. najæ* Nicoll (1912) from the Indian Cobra, though the length of the intestinal diverticula and the size of the suckers appear to be characters sufficient to separate it from that species.

The length of mature specimens is 3-4 mm. and the maximum breadth .9-1.0 mm. just behind the ventral sucker. The cuticle is beset with fairly prominent spines throughout practically its whole extent.

The oral sucker measures .24-.28 mm. in diameter and the ventral sucker .28-.34 mm. The latter is almost invariably transversely elongated, its average diameter being $.29 \times .33$ mm. The oral sucker is sometimes elongated, sometimes transverse, the latter being usually the case, and its average dimensions are $.25 \times .26$ mm. The ratio of the mean diameters of the suckers is therefore about 5:6; it is always greater than 4:5 and never greater than 6:7. In *S. najæ* and *S. serrata* the suckers are much more nearly equal. The ventral sucker is situated at a distance of .6-.8 mm. from the anterior end of the body. The neck thus comprises only about one-fifth of the body-length, but it may be remarked that the specimens were somewhat contracted.

There is no prepharynx, and the pharynx measures $.17 \times .13$ mm. The oesophagus is about .1 mm. long, and the intestinal bifurcation takes place close in front of the ventral sucker. The intestinal diverticula are practically equal in length, and extend to a distance of .65-.9 mm. from the posterior end. The average in about a dozen specimens was .76 mm., which is almost exactly two-ninths of the body-length. They are therefore practically about the same length as those in *S. serrata*.

The median genital aperture is immediately in front of the ventral sucker. The cirrus-pouch just reaches the posterior border of the ventral sucker, and is frequently contiguous with the ovary. The latter is globular, with a diameter of .2 mm. Behind it lies the receptaculum seminis. The anterior testis, on the left, lies about .25 mm. from the posterior border of the ventral sucker, though the distance varies from .18 mm. to .38 mm., according to the state of contraction. The posterior testis, on the right, is separated from the other by a distance of .17 mm., though this again varies. The anterior border of the right testis is usually a little in advance of the posterior border of the left.

The yolk-glands have the usual situation, almost entirely

external to the intestinal diverticula, and extend from the posterior border of the ventral sucker to the middle of the anterior testis. The uterus, which is voluminous, bears a close resemblance to that of *S. serrata*, and the ova measure $\cdot 039\text{--}\cdot 047 \times \cdot 019\text{--}\cdot 020$ mm.

Family DICROCOELIIDÆ.

6. *LYPEROSOMUM SCITULUM*, sp. n. (Pl. III. fig. 6.)

Four specimens of this species were taken from the liver of a Purple-capped Lory (*Lorius domicella*). It is a greatly elongated form, measuring 6·8–7·2 mm. in length. The breadth is fairly uniform, but attains its maximum (·8 mm.) across the ventral sucker. There are no cuticular spines.

The oral sucker is almost terminal, and has a diameter of ·45 mm.; the ventral sucker is slightly smaller, ·42 mm., and is situated 1·33 mm. from the anterior end. The pharynx is contiguous with the oral sucker, and has a diameter of ·14 mm.; the œsophagus is about the same length. The narrow tortuous intestinal diverticula extend down the sides of the body to a distance of about 2 mm. from the tip of the tail. They are of unequal length, sometimes the right, sometimes the left being the longer.

The anterior testis is separated from the ventral sucker by a space of ·33 mm. The posterior testis lies about the same length behind the first, the latter being close against the right intestinal diverticulum and the former against the left diverticulum. They are oval bodies measuring about $\cdot 25 \times \cdot 33$ mm. The space between the second testis and the ovary is equal to that between the two testes. The ovary is a transversely oval body situated in the middle line and measuring $\cdot 21 \times \cdot 24$ mm. The genital aperture lies over the intestinal bifurcation. The cirrus-pouch is fairly stout, and extends to the anterior border of the ventral sucker. It contains a highly convoluted, voluminous vesicula seminalis and a moderately long prostate and ductus.

The yolk-glands are limited to an area on each side of the body about the level of the ovary. They are variable in extent, but as a rule their anterior limit is on a level with the second testis, while their posterior limit is about half as far again on the other side of the ovary. They are usually more extensive on one side of the body than on the other. They almost completely overlap the intestinal diverticula. The uterus is very highly convoluted, the loops being mostly transverse. It fills up almost all the posterior part of the body not occupied by the genital glands, which it does not overlap. It does, however, overlap the intestinal diverticula to a very considerable extent. The eggs are extremely numerous, and measure $\cdot 029 \times \cdot 019$ mm. The older ones contain the characteristic miracidium larva.

7. *LYPEROSOMUM DIREPTUM*, sp. n. (Pl. III. fig. 7.)

Three fragments of this species were obtained from the liver of a Crested Curassow (*Crax alector*). From these it was possible to get a fairly accurate idea of the whole animal. It is about 9 mm. long and about .9 mm. broad at its broadest part, which is just behind the ventral sucker. The neck narrows rather abruptly, but the posterior part of the body gradually narrows to an acutely pointed tail. At a distance of 1 mm. from the tip of the tail the breadth is less than half what it is behind the ventral sucker. There are no cuticular spines.

The globular oral sucker measures $.35 \times .39$ mm., the ventral sucker $.46 \times .42$ mm., and the latter is 1.03 mm. from the anterior end. In one fragment belonging to a specimen apparently well over 10 mm. in length, the ventral sucker had a diameter of .54 mm. and the maximum breadth of the body was 1.1 mm. The pharynx is contiguous with the oral sucker, and measures $.17 \times .14$ mm. There is practically no oesophagus, the intestinal diverticula branching out directly from the pharynx. The diverticula terminate a considerable distance from the tip of the tail, but the ends are obscured by the uterus, and could not be made out.

The genital aperture lies immediately behind the pharynx. The small slender cirrus-pouch, .3 mm. in length, is slightly curved, and does not reach the ventral sucker. The testes are close behind the ventral sucker, the left being in advance, but only by the distance of its own diameter, so that the posterior border of one is on the same level as the anterior border of the other. They are almost globular, and their diameter varies from .24 mm. to .31 mm.

The globular ovary is separated from the posterior testis by a space of .6 mm. It lies somewhat to the right side, and is rather larger than the testis, having a diameter of .34-.41 mm. Behind it lies a small globular receptaculum seminis. The yolk-glands are much more extensive than in the preceding species. They reach from the level of the posterior testis to halfway between the ovary and the tip of the tail. They are more extensive on one side than on the other. The uterus is very voluminous and highly convoluted, but the convolutions are not quite so regularly disposed as in *L. scitulum*. The very numerous eggs measure $.025-.028 \times .019-.021$ mm.

8. *BRACHYCELIUM OBESUM*, sp. n. (Pl. III. fig. 8.)

A few specimens of this species were obtained from the intestine of a Summer Snake (*Contia aestiva*), which died in the Gardens on July 2nd, 1911. They were all, unfortunately, in a very contracted state, and it was only with some difficulty that their internal anatomy could be made out. At first sight they appeared to be identical with *B. salamandrae*, but their exceedingly small size and the fact that even the smallest was fully mature, raised

suspicion that this could not be the case. It was difficult, however, to obtain other grounds for regarding them as a distinct species. These relate only to slight differences in the size of the suckers, the cirrus-pouch, and the ova.

The body in its contracted state is plump and equally rounded at both ends. In some specimens each end is curled ventrally. The length of the smallest specimen was .75 mm. and of the largest 1.4 mm., though the latter had been subjected to a certain amount of pressure. In the natural state the length is probably 1-1.5 mm. The greatest breadth, in the middle of the body, is .4-.65 mm. The cuticular spines are rather minute.

The suckers are more unequal than in *B. salamandræ*. The diameter of the oral sucker is .17-.25 mm., the average being .22 mm. The ventral sucker only measures .11-.15 mm., with an average of .135 mm. The ratio is therefore very nearly 5:3 instead of 5:4, as in *B. salamandræ*. The ventral sucker is also nearer the middle of the body, being about two-fifths of the total length from the anterior end.

The pharynx measures .075 × .07 mm.; the œsophagus is short, and the dilated intestinal diverticula reach the level of the middle of the ventral sucker.

The genital aperture has the same position as in *B. salamandræ*, but the cirrus-pouch is much longer and more slender, and it extends right across the ventral sucker to its posterior border. It contains a very large bipartite vesicula seminalis, of which the posterior portion is the larger. The transversely oval ovary lies on the left side immediately behind and overlapping the ventral sucker. Just behind it, and a little external, lies the left testis, while on the other side, on the same level, lies the right testis. The ovary measures .13 × .07 mm.; the testes are somewhat larger. The yolk-glands extend from about the middle of the oral sucker to the level of the ovary. The uterus is very voluminous, and fills up the whole of the posterior part of the body. The arrangement of the convolutions cannot be made out, as they are so closely packed together, but it is noticeable that most of the young eggs are near the tail, while the older eggs occupy a more forward position. The eggs are thick-shelled and somewhat larger than those of *B. salamandræ*, measuring .050-.052 × .034-.036 mm.

This species differs from *B. hospitale* Stafford (1903) in having relatively larger and more unequal suckers. The intestinal diverticula are somewhat longer, and the ova are considerably larger. It is altogether a much smaller species.

Family ECHINOSTOMIDÆ.

9. ECHINOSTOMUM ALIUD, sp. n. (Pl. IV. figs. 9, 9 a.)

Four specimens of this parasite were obtained from the intestine of a Ruddy Flamingo (*Phœnicopterus ruber*). It is an elongated,

somewhat flat species, with a pronounced cervical concavity. As in many other species of the genus, the head has a tendency to be bent sharply on to the ventral surface of the body.

The specimens measured 2.9–6.3 mm. in length. One, 4.6 mm. in length, was immature, but another, of 5.6 mm. in length, was full of ova, so that the maturity length is probably about 5 mm. The greatest breadth, across the ventral sucker, is about one-fifth of the length. Behind the ventral sucker the breadth is fairly uniform, but the tail is distinctly pointed. The breadth across the head is about one-tenth of the body-length.

There are 35 cephalic spines, arranged in the typical fashion in two uninterrupted rows, with a group of five terminal spines at each end. In the anterior row the spines are slightly shorter than in the posterior row, the average size being .099 mm. and .103 mm. respectively. The terminal spines are slightly smaller, measuring .093 mm. The shortest spine on either side is the superficial spine third from the inner end of the terminal group. In the only specimen in which its dimensions could be accurately determined, it measured .091 mm. on the right side and only .078 mm. on the left. The cephalic spines present two peculiarities which have not apparently been observed in any hitherto described species of *Echinostomum*. In the first place their shape is unusual. Instead of the common symmetrical peg-shape, their distal end is inflated in the form of a somewhat triangular knob, which is slightly sculptured. The knob is situated on the upper surface of the spine, and comprises about one-third of its total length. An idea of its shape will best be gathered from reference to fig. 9a. There is the further peculiarity that each spine is connected to the edge of the cephalic disc by a thin web-like membrane which is joined to the spine along pretty nearly its whole length.

The whole of the neck, both dorsally and ventrally, is covered with stout cuticular spines, but these do not extend very far beyond the ventral sucker.

In a 5.6 mm. specimen the large oral sucker measures .22 mm. in diameter, and the ventral sucker .72 mm. The latter is usually globular, but in one case it was somewhat deepened. It lies at a distance of 1.43 mm. from the anterior end. The neck is thus a little more than one-fourth of the body-length. There is a short prepharynx about .06 mm. in length, followed by a pharynx measuring .19 × .13 mm. The œsophagus is about .46 mm. in length, and the bifurcation occurs just in front of the ventral sucker. The diverticula are somewhat crenated, and extend right to the posterior end of the body.

The genital aperture lies in the middle line just over the intestinal bifurcation. The cirrus-pouch is small and stout, and overlaps the ventral sucker only to a slight extent. Its dimensions are .45 × .18 mm., and it encloses a convoluted vesicula seminalis, a short pars prostatica, and a twisted ductus and cirrus. The testes are rather small and of irregular contour, there being

usually a slight indentation on either side about the middle of their length. Their dimensions are $\cdot 34 \times \cdot 25$ mm. The posterior testis is a trifle larger than the anterior one. They are very close together, but are not quite contiguous. In front they are separated from the ovary by a space of $\cdot 15$ mm.; behind them the post-testicular space is $1\cdot68$ mm. in length.

The small transversely oval ovary is situated $1\cdot02$ mm. behind the ventral sucker. It is almost median, and measures $\cdot 15 \times \cdot 21$ mm. The yolk-glands are rather restricted in extent. On each side they reach the posterior border of the ventral sucker; posteriorly they cease at some distance from the tip of the tail. They are for the most part confined to the outer side of the intestinal diverticula, and overlap them only to a very slight extent. The transverse yolk-ducts cross between the ovary and anterior testis. The uterus does not overlap the intestinal diverticula, and is confined between the ovary and the ventral sucker. The ova are very large, measuring $\cdot 114\text{--}\cdot 122 \times \cdot 069\text{--}\cdot 074$ mm.

Family CLINOSTOMIDÆ.

10. HARMOTREMA INFECUNDUM, gen. et sp. n. (Pl. IV. fig. 10.)

A considerable number of specimens of this species was obtained from the intestine of Smyth's Water-Snake (*Grayia smythii*). It is one of the most remarkable forms in the present collection.

It is a small, rather flat species, white in colour and with the edges of the body thrown into irregular wrinkles. The cuticle is unarmed.

It is about 2 mm. in length, with a fairly uniform breadth of $\cdot 6$ mm. Both ends are slightly pointed. The suckers are small and feeble, the oral having a diameter of $\cdot 13$ mm. and the ventral $\cdot 08 \times \cdot 10$ mm. The latter lies $\cdot 8$ mm. from the anterior end.

There is no prepharynx; the pharynx measures $\cdot 06 \times \cdot 04$ mm., and the œsophagus is about the same length as the pharynx. The intestinal diverticula are wide and sinuous, and reach the posterior end of the body. Behind the ventral sucker they usually bend inwards before passing out again to make room for the genital glands. At their termination they again turn in towards the middle line.

The genital aperture is situated on the left side of the body, internal to the intestinal diverticulum and almost midway between the ventral sucker and the posterior end of the body. The curious thin-walled cirrus-pouch stretches forwards from the genital aperture in a zigzag or sinuous fashion, and its proximal end lies against the right intestinal diverticulum. It contains a bipartite vesicula seminalis, of which the proximal part is oval and the distal elongated. There is a moderately

long fusiform pars prostatica and a long curved ductus ejaculatorius.

The testes are two irregularly lobed bodies lying behind the cirrus-pouch. The anterior is just behind the genital aperture but on the right side of the body. The posterior lies between the ends of the intestinal diverticula, and is separated from the end of the body by a space equal to its own diameter.

Between the testes lies the much smaller ovary. It is also irregularly lobed, but not so distinctly as the testes. It is separated from the posterior testes by a large yolk receptacle. The yolk-glands extend a considerable part of the length of the intestinal diverticula and lie both internally and externally to them, but not to any great extent dorsally or ventrally. Their anterior limit is midway between the intestinal bifurcation and the ventral sucker. Posteriorly they cease at the ends of the intestines. The uterus is extremely short and does not usually contain more than two eggs. The latter are comparatively huge but very variable in size. The normal size appears to be about $\cdot 15\text{--}18 \times \cdot 08\text{--}11$ mm. They lie alongside the ovary and testes.

This species evidently bears a close resemblance to the genus *Harmostomum*, but differs from it particularly in the position of the uterus and the size of the eggs.

HOLOSTOMATA.

11. HEMISTOMUM CANALICULATUM, sp. n. (Pl. IV. fig. 11.)

A few specimens of this parasite were obtained from the intestine of an Egyptian Eagle-Owl (*Bubo ascalaphus*). It is of moderate size, $1\cdot 6\text{--}2\cdot 9$ mm. in length. The anterior part of the body is considerably longer than the posterior part, in the ratio of 5 : 3 on an average. When expanded the anterior part of the body is almost oval in outline, with a pointed tip. The lateral glandular pits are not very well marked. When contracted the body is almost uniformly cylindrical. The long axis of the two parts are almost in the same straight line; so that there is little dorsal flexure. The posterior part of the body may attain a breadth of $\cdot 7$ mm.

The small oral sucker measures $\cdot 08\text{--}09$ mm. The ventral sucker is slightly larger ($\cdot 1$ mm.), and is situated at a distance of $\cdot 6$ mm. from the anterior end in a specimen $2\cdot 4$ mm. long. The pharynx is contiguous with the oral sucker and somewhat larger than it, measuring $\cdot 08\text{--}1 \times \cdot 06\text{--}08$ mm. The short oesophagus measures only $\cdot 03\text{--}04$ mm. The diverticula have the usual configuration.

The most characteristic feature of the species is the clinging-plug, which is situated immediately behind the ventral sucker. It is an oval structure about four times as long as the ventral sucker and two or three times as broad. It does not conceal

the ventral sucker, but in the older specimens it overlaps the posterior border of the sucker. It is not much raised above the surface of the body, and is traversed by a deep median longitudinal furrow which extends along its whole length. In well-expanded specimens the furrow is much shallower. A similar furrow exists in *H. pileatum* (Rud.).

The genital glands do not display any striking peculiarities, except that the testes are reniform in transverse section and the yolk-glands extend forward only to about .5 mm. from the anterior end. Their anterior edge forms a semi-circle with the convexity directed forward.

The ova measure .105-.11 × .065-.07 mm.

This species bears most resemblance to *H. spathula* (Creplin), but differs from it in several important details. In the latter the two parts of the body are nearly equal; the oral sucker and the pharynx are only half as large, while the clinging-plug is much larger and does not display the longitudinal furrow. The yolk-glands, too, are probably more extensive.

The following is a list of the hosts and of the Trematode parasites obtained from them:—

MAMMALS.

ANOA DEPRESSICORNIS.

Fasciola gigantea (Cobbold) Liver.

BIRDS.

CIRCUS ÆRUGINOSUS. Marsh Harrier.

Metorchis crassiusculus (Rud.) Liver and Gall-bladder.

BUBO ASCALAPHUS. Egyptian Eagle-Owl.

Hemistomum canaliculatum Nicoll Intestine.

LARUS RIDIBUNDUS. Black-headed Gull.

Gigantobilharzia acotylea Odhner Mesenteric veins.

LARUS FUSCUS. Black-backed Gull.

Tocotrema lingua (Creplin) Intestine.

LARUS ATRICILLA. Laughing Gull.

Tocotrema lingua (Creplin) Intestine.

ALCA TORDA. Razorbill.

Hemistomum pileatum (Rud.) Intestine.

Metorchis xanthosomus (Creplin) Gall-bladder.

CEDEMIA NIGRA. Black Scoter.

Catatropis verrucosa (Froelich) Cæca.

Paramonostomum alveatum (Mehlis) Intestine.

LORIUS DOMICELLA. Purple-capped Lory.

Lyperosomum scitulum Nicoll Liver.

PHŒNICOPTERUS RUBER. Ruddy Flamingo

Echinostomum aliud Nicoll Intestine.

CRAX ALECTOR. Crested Curassow.

Lyperosomum direptum Nicoll Liver.

REPTILES.

TROPIDONOTUS ORDINATUS. Striped Snake.	
<i>Cercaria ordinata</i> Nicoll	Mesentery.
<i>Diplostomum sirtale</i> Nicoll	Mesentery.
<i>Mediorima propria</i> Nicoll	Intestine.
TROPIDONOTUS PISCATOR. Indian River-Snake.	
<i>Styphlodora persimilis</i> Nicoll	Ureters.
TROPIDONOTUS NATRIX. Common Snake.	
<i>Cercorchis nematoides</i> (Muhling)	Intestine.
NAJA TRIPUDIANS. Indian Cobra.	
<i>Xenopharynx solus</i> Nicoll	Gall-bladder.
<i>Styphlodora najæ</i> Nicoll	Ureters.
PHILODRYAS SCHOTTI. Schott's Snake.	
<i>Opisthogenes interrogativus</i> Nicoll	Intestine.
GRAYIA SMYTHII. Smyth's Water-Snake.	
<i>Harmotrema infecundum</i> Nicoll	Intestine.
VIPERA ASPIS. Asp Viper.	
<i>Opisthioglyphe adulescens</i> Nicoll	Intestine.
<i>Cercaria ordinata</i> Nicoll	Mesentery.
CONTIA ÆSTIVA. Summer Snake.	
<i>Brachycælium obesum</i> Nicoll	Intestine.
UROMASTIX ACANTHINURUS. Spiny-tailed Mastigure.	
<i>Ommatobrephus singularis</i> Nicoll	Intestine.

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EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Mediorima propria*. × 20.
 2. *Ommatobrephus singularis*. × 40.
 3. *Opisthioglyphe adulescens*. × 70.

PLATE II.

- Fig. 4. *Opisthogenes interrogativus*. $\times 25$.
 5. *Styphlodora persimilis*. $\times 40$.

PLATE III.

- Fig. 6. *Lyperosomum scitulum*. $\times 23$.
 7. *Lyperosomum direptum*. $\times 18$.
 8. *Brachycœlium obesum*. $\times 100$.

PLATE IV.

- Fig. 9. *Echinostomum aliud*. $\times 20$.
 9a. " " Cephalic spine. $\times 250$.
 10. *Harmotrema infecundum*. $\times 60$.
 11. *Hemistomum canaliculatum*. Transverse section through
 clinging-plug. $\times 65$.

Figures 1-10 are drawn from the ventral surface.

C.B. Cirrus-pouch.
Ex. Excretory vesicle.

K.St. Ovary.
T., T₁, T₂. Testes.

10. On the Skull of a Pariasaurian Reptile, and on the Relationship of that Type. By D. M. S. WATSON, M.Sc., F.Z.S., Lecturer on Vertebrate Palæontology in University College, London.

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(Text-figures 1-7.)

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In 1838 Andrew Geddes Bain discovered, on the Blinkwater Commonage, in Cape Colony, the skull and a good deal of the skeleton of a large reptile, which was subsequently described by Owen as *Pariasaurus serridens*. Our knowledge of the structure of the animal remained very slight until H. G. Seeley, in 1888, described a skull and axial skeleton referred to *Pariasaurus hombidens* *. Some years later he obtained in South Africa a fine skeleton, and the imperfect skull and axial skeleton of another, of which he gave a good description.

In 1893 E. T. Newton gave an excellent account of the skull of *Elginia mirabilis*, a closely allied reptile from the Upper Permian Culties Hillock Sandstone of Elgin.

A. S. Woodward, in 1898, published a diagram of the palate of *Pariasaurus*, which he correctly interpreted. Broom, in several papers, has added to our knowledge of *Pariasaurus* and allied types; and J. Versluys has corrected his account of the palate.

* It is almost certain that *P. hombidens* is not congeneric with *P. serridens*. As this paper is purely morphological I have postponed all discussion of nomenclatural difficulties to a more fitting occasion.

Despite this large amount of work, practically nothing is known of the detailed structure of the skull, and I was therefore very pleased to find that a fossil I collected on the farm Hottentots Rivier, Gouph, Beaufort West, Cape Colony, would enable me to give a nearly complete description of the skull. With this description *Pariasaurus* becomes, on the whole, the best known Permian vertebrate.

The material I have used consists of:—

I. A skull from Hottentots Rivier. This apparently belongs to the same species as the skeleton in the South African Museum described by Broom as *P. serridens*, a species to which it certainly does not belong. It differs from *P. baini* in many features of the skull and skeleton, and is probably quite worthy of generic rank.

This specimen consists of the entire brain-case, which has been very completely cleaned inside and out, the posterior part being divided by a sagittal cut, and the anterior part sliced through horizontally. The whole of the right side of the skull-roof is very perfectly preserved, and the fragment extends so far across the middle line as to give the shape of the skull and the complete structure with certainty. The sutures are shown only on the inner surface. The palate is missing.

II. No. 49426, British Museum (Natural History), is the skull of the specimen collected by T. Bain at Palmiet Fontein, Dist. Beaufort West, described by Seeley as *P. bombidens*. His lithographic figures give a good idea of the specimen, which, however, has been very much more developed, the palate having been completely freed from the stone on both palatal and dorsal surfaces and the lower jaw disarticulated.

Many, but not all, Prof. Seeley's sutures are correctly determined, and it is certain that the structure is essentially similar to that of specimen I.

III. R. 1970 is the Tamboer Fontein specimen of *P. bombidens* collected by Prof. Seeley; it shows the entire structure of the palate well-preserved and perfectly prepared, the sutures being visible on the dorsal surface.

DESCRIPTION OF SKULL, drawn mainly from the *Hottentots Rivier* specimen; others are indicated when used.

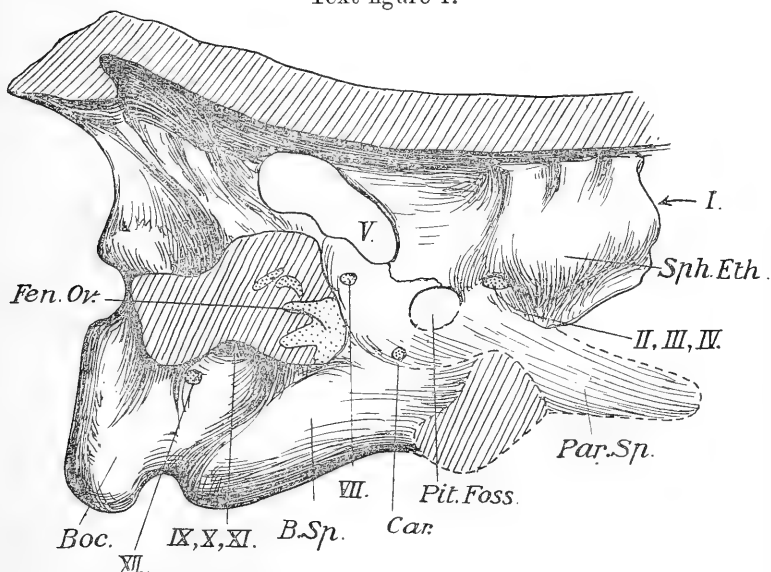
The bones of the brain-case are fused into a single mass of bone in which sutures are not distinguishable. The various regions are, however, readily identified, and are used in the following account.

Basioccipital.—The basioccipital is a large bone whose posterior end forms the condyle. This is almost exactly circular, but its border is slightly depressed below the foramen magnum. The outer part of the condyle is rounded, but the centre is depressed into a deep conical notochordal pit exactly similar to that which occurs in every vertebral centrum of the animal. The condyle is separated off from the body of the bone by a neck formed by a

groove running round the bone, which particularly impresses the lower surface. In section a disturbance of the cancellar tissue suggests the point of separation of the basisphenoid. The upper surface of the basioccipital supports the very massive exoccipital, in front of which its upper surface is excavated on each side of the middle line by a deep pit, continued outwards by a groove which forms the lower half of the enormous foramen jugulare.

The lower part of the basioccipital is almost entirely concealed by the overlapping basisphenoid, but it is produced in low yet massive tubera basisphenoidales.

Text-figure 1.



The cranium of "*Pariasaurus*," the Hottentots Rivier specimen, viewed from the side. ($\times \frac{1}{3}$).

Boc., Basioccipital; *B.Sp.*, Basisphenoid; *Car.*, Canal for internal carotid artery; *Fen.Ov.*, Fenestra ovalis; *Par.Sp.*, Parasphenoid; *Pin.*, Pineal foramen; *Pit.Foss.*, Pituitary fossa; *Sph.Eth.*, Sphenethmoid. The figures I-XII refer to the exits of the cranial nerves.

Basisphenoid.—The basisphenoid covers the lower surface of the anterior part of the basioccipital, sending back processes over those of the basioccipital to form the tubera. They are continued forward as strong rounded ridges on each side of the bone which pass into the great basiptyergoid processes, very well shown on R. 1870. These project downwards and outwards, leaving between them a deep channel on the under surface of the bone. They are of irregular shape, and the pterygoids articulate with a

very large area of the outer surface. In advance of them a narrow rostrum, which is probably to some extent parasphenoid, projects forward and articulates with a special facet on the dorsal surface of the pterygoids so as to divide completely the interpterygoid vacuity.

Although the lower surface of the basisphenoid is very long its upper surface is short, owing to the great anterior production of the basioccipital. The lateral border of the upper surface and a good deal of the side of this bone are covered by the prootic. In advance of this region the bone suddenly narrows, its sides being in contact with the sphenethmoid. The front of the bone terminates in a smoothly rounded edge, which is the back of the opening to the pituitary fossa. This runs backwards with sides widely open above the basipterygoid processes; its base is closed by the upper surface of the rostrum, and in front it passes into the cavity of the sphenethmoid. The internal carotids enter the pituitary fossa by a single foramen, which leads into a canal passing down in the body of the basisphenoid for about a centimetre and then splitting into two, which pass out on the sides of the bone above the basipterygoid processes. In front of the pituitary fossa the rostrum is in contact with the under surface of the sphenethmoid.

Otic bones.—The side walls and roof of the posterior part of the brain-case are formed by the fused otic bones and exoccipitals. The exoccipital part of the mass forms a massive pillar pierced near its base by a single small foramen for the XIIth nerve; its anterior border forms the back of the huge jugular foramen, which is about 1.5 cm. in diameter; it must form part of the very powerful paroccipital process, and it is not improbable that the two exoccipitals met above the foramen magnum.

The front border of the jugular foramen must be formed by the opisthotic, which is so fused with the prootic and supraoccipital that it is hopeless to separate them; the three bones with the exoccipital form a very massive paroccipital process, whose outer end is firmly united with the tabular and squamosal by an irregular suture seen only in fractures.

The foramen jugulare issues below and behind the process, and on its lower front surface, not very far out, is the fenestra ovale, a large hole of irregular shape.

In section, on the left side, the horizontal semicircular canal and part of the vestibule are seen filled with matrix.

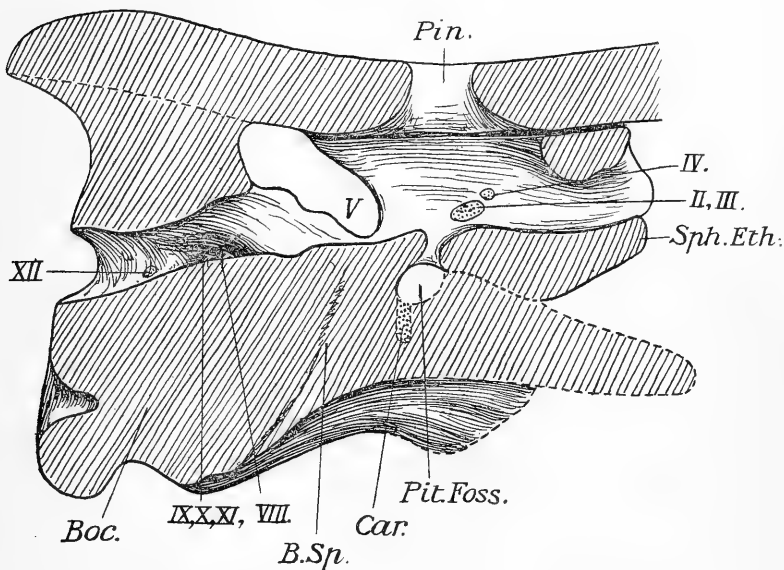
The foramen through which the VIIIth nerve gains entrance to the ear lies far out on the front wall of the bony canal, which forms the foramen jugulare. The foramen is a small one, the vestibule being separated from the brain-cavity by bone and not merely a membrane, as in most early reptiles.

The aqueductus fallopii for the VIIth nerve has an exit on the outer surface of the prootic in advance of and slightly above the fenestra ovale; its opening to the brain-cavity is not quite certain.

The front border of the prootic forms a smooth curve with a notch at the bottom for the exit of the Vth and VIth nerves.

The supraoccipital part of the brain-case is produced upward as a very massive process of roughly quadrangular section channelled and grooved vertically and fused with the postparietals over a large area. This separates the large posttemporal fossæ.

Text-figure 2.



The cranium of "*Pariasaurus*," the Hottentots Rivier specimen, in sagittal section, $\times \frac{1}{2}$.

Reference-letters as before.

The *Sphenethmoid*.—The anterior part of the brain is surrounded by a single bone, which I can only compare with the sphenethmoid of a frog.

Posteriorly, on either side of the pineal foramen, this bone forms a flat thin plate which thickens and turns inwards as it passes downwards until it unites with the side of the basisphenoid above the pituitary fossa. In this region the brain-cavity is roofed solely by the parietals, but farther forward the cavity of the sphenethmoid contracts very much, and the bone becomes quite continuous over the brain: in this region the bone is massive although of very loose texture. Farther forward the cavity suddenly widens.

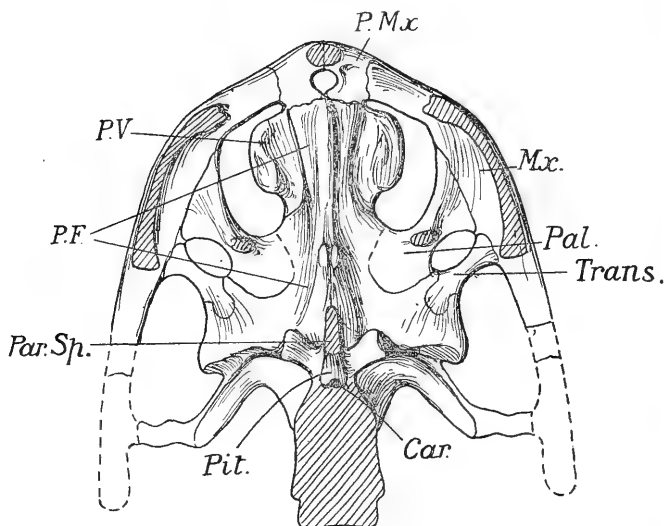
The thick floor is directly continuous with the parasphenoidal rostrum, from which it is not visibly separated by suture (49426).

The bone is apparently all one, there being no visible sutures, and it is very clearly distinct from the membrane bones of the skull roof.

Viewed from within its floor is pierced by two pairs of foramina: the posterior are large rounded openings, for the IInd and IIIrd nerves; the anterior are much smaller foramina lying somewhat outside the others, and possibly transmitted the IVth cranial nerves. These two foramina have a common opening on the outside.

The olfactory nerves passed out by the widely open front of the bone.

Text-figure 3.



The palate of *Pariasaurus bombidens*, $\times \frac{1}{2}$.

Viewed from above, the top of the skull being cut off about 5 cm. above its dorsal surface.

Reference-letters as before, with:—*Mx.*, Maxilla; *Pal.*, Palatine; *P.V.*, Prevomer; *P.F.*, Pterygoid; *Trans.*, Transpalatine.

The *Palate*.—The general form of the palate has long been known, and the distribution of the teeth with which it is armed was fully described by Seeley (1892).

R. 1870, which shows the sutures between the bones on the dorsal surface, 49426, which illustrates very well its general form and relation, and another specimen, collected by myself at Hottentots Rivier, enable me to complete our knowledge.

Pterygoid.—The pterygoid is a large triradiate bone. It articulates by an immovable and very powerful junction with the basiptyergoid process of the basisphenoid.

The anterior ramus runs forward at a lower level than the basipterygoid process, in contact with its fellow, nearly to the extreme front of the skull, where the bone ends in an overlap on the palatal process of the premaxilla. The two taken together form a powerful ridge along the dorsal surface of the palate, which is particularly high in the region of the prevomers, and further back is thickened to articulate with the anterior end of the parasphenoidal rostrum.

The front part of the pterygoid is underlain by the prevomer, as is well seen in a section of the second Hottentots Rivier specimen.

The lateral border of the anterior ramus is in contact with the palatine, and the external ramus supports the ectopterygoid and with it forms the small pterygoid flange which faces the inner side of the lower jaw.

The posterior ramus runs outwards and backwards from the basipterygoid process; it forms a deep plate very thick and solid below, nearly the whole of whose anterior face is covered by the quadrate. This flange reaches nearly to the roof of the skull, and at its upper edge apparently touches, in 49426, a special process of the squamosal which will be described later.

Epipterygoid.—No. 49426 on the right side shows appearances suggesting the presence of a small epipterygoid resting on the upper surface of the pterygoid. I have seen a similar suggestion in another specimen, but am not prepared definitely to affirm the presence of the bone.

Prevomer.—The prevomer is a large thick bone which meets its fellow in the middle line, whose dorsal surface is partly covered by the pterygoid and whose lower surface supports two irregular rows of teeth: these are quite large, recurved, and sharply pointed; in section they are seen to be set in distinct sockets.

Palatine.—The extension of the palatine on the buccal surface of the palate cannot be determined. An interesting feature of its dorsal surface is the presence of a process which is directed upwards and articulates with a corresponding descending process of the prefrontal. The outer edge of the palatine articulates wholly with the maxilla.

Ectopterygoid.—An ectopterygoid is undoubtedly present. It unites with the external ramus of the pterygoid and passes outwards behind the suborbital vacuity to articulate with the maxilla, lachrymal, and jugal.

A very curious feature of the palate is the presence of a large round opening between the palatal processes of the premaxillæ, which probably housed an intermaxillary gland.

Quadrate.—The quadrate is a large bone standing nearly vertical in the skull. Its lower border forms the condyle for the lower jaw, which is placed nearly transversely.

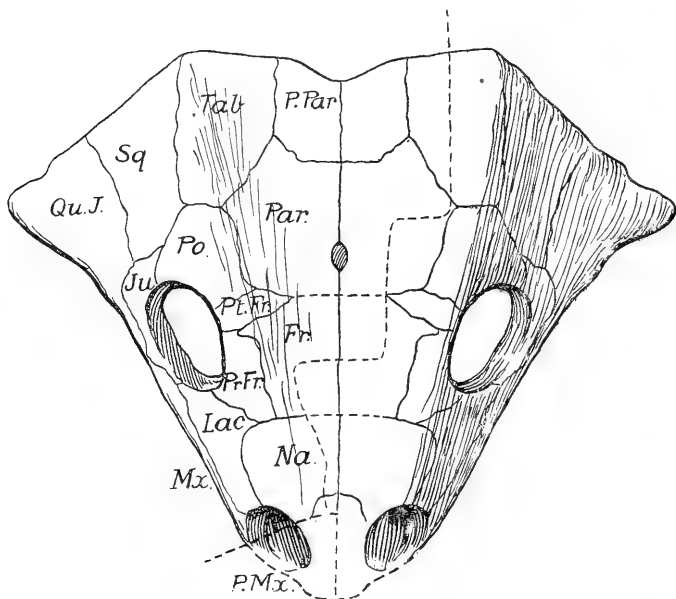
The bone rises above this as a plate whose outer border is notched at one place by the very small quadrate foramen, but is

otherwise in contact with the quadratojugal and squamosal throughout its whole height.

The body of the bone passes gradually into a powerful pterygoid ramus, which covers nearly the whole of the posterior ramus of the pterygoid.

The upper border of the bone is covered by a special process of the squamosal.

Text-figure 4.



The skull of "*Pariasaurus*," Hottentots Rivier specimen, $\times \frac{1}{6}$. Dorsal aspect.

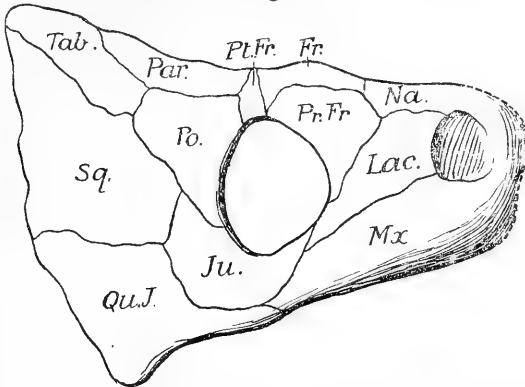
The sutures have only been seen on the inner surface and are drawn here on the assumption (apparently justified by the specimen) that they pass through at right angles to the surface. The part to the left of the thick dotted line is not preserved in the specimen.

Fr., Frontal; *Ju.*, Jugal; *Lac.*, Lachrymal; *Mx.*, Maxilla; *Na.*, Nasal; *P.Par.*, Postparietal; *Po.*, Postorbital; *Pt.Fr.*, Postfrontal; *Pr.Fr.*, Prefrontal; *Par.*, Parietal; *Qu.*, Quadrate; *Qu.J.*, Quadratojugal; *Sq.*, Squamosal; *Tab.*, Tabulare.

Roof of the Skull.—The general structure of the roof of the skull will be more readily understood from text-figs. 4 and 5 than from any description. It must, however, be remembered that all the sutures shown in these figures have been seen only on the inside of the skull, their positions on the outside being drawn on the assumption that the sutures pass straight through at right angles to the surface; observations on fractures show that this is really the case. It is impossible to give an intelligible figure of

the inside of the skull, and no errors of any morphological importance can possibly be introduced by the method of figuring I have employed here.

Text-figure 5.



The skull of "*Pariasaurus*," Hottentots Rivier specimen, $\times \frac{1}{6}$. Side view.

Reference-letters as before.

The most striking features of the skull pattern are:—

1. The very large size of the parietals, frontals, and nasals.
2. The very reduced postfrontal wedged in between the frontal, prefrontal, parietal, and postorbital.
3. The very great downward extension of the prefrontal, so that it nearly reaches the jugal.
4. The fact that, as is usually the case in primitive reptiles, the lacrymal enters into both the nostril and the orbit.
5. The shallowness of the maxilla.
6. The fact that the quadratojugal meets the maxilla.
7. The large size of the postparietal and tabulare, which are placed immediately behind and in the same plane as the parietal and postorbital.
8. The reduction of the bones in the temporal region to one on each side.

*Description of the Attachment of Bones of the Cranial Roof
to Underlying Bones.*

Postparietal.—The two postparietals fuse in the middle line, no suture being visible. Their posterior edge projects freely at the back of the skull, and the top of the supraoccipital is tightly fused on to their lower surface near the front.

Parietal.—The parietals completely surround the pineal foramen, which is of moderate size. Near their posterior border they are in contact with the supraoccipital, and further forward with the sphenethmoid.

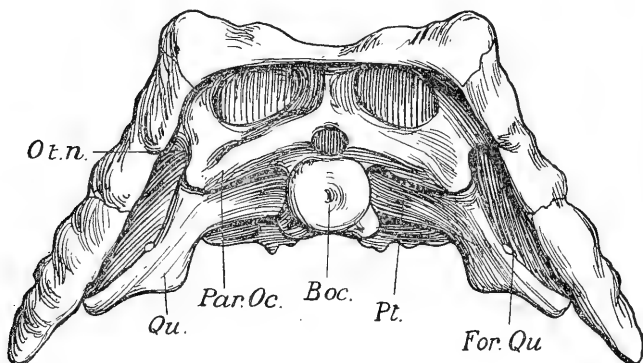
Frontal.—The frontals are in contact with the anterior part of the sphenethmoid.

Tabulare.—The tabulare is a large bone which has a large and very firm attachment to the end of the paroccipital process.

Squamosal.—The squamosal is a large bone on the side of the skull which has an articulation with the outer edge of the quadrate, and in addition sends a special delicate process back over the top of that bone. In the Hottentots Rivier specimen these two bones are not quite in contact, but in 49426 they are for a long distance, and it is very probable that the end of the squamosal process is in contact with the pterygoid.

The squamosal is produced into a plate on the outer surface of the skull behind the quadrate, and on the border of this, just below the paroccipital process, is a small smooth groove, the last remnant of the otic notch.

Text-figure 6.



The skull of "*Pariasaurus*," Hottentots Rivier specimen, restored, from behind.

Reference-letters as before, with *Ot.n.*, otic notch.

Quadratojugal.—The quadratojugal is a very large bone which has an articulation with the outer side of the quadrate, and helps to form the minute foramen quadrati. It is, however, largely produced behind and below this bone.

Maxilla.—The maxilla is a shallow bone, articulating along the whole of its upper edge with the lachrymal and posteriorly with the jugal and quadratojugal. It is almost certain that it really overlaps the lachrymal so as to be rather higher than it is represented in text-fig. 5.

It bears numerous teeth, which are inserted in sockets and very firmly held by the development of bone round their roots. On the inner side the maxilla articulates with the ectopterygoid and the palatine.

Prefrontal.—The large prefrontal sends a process downwards

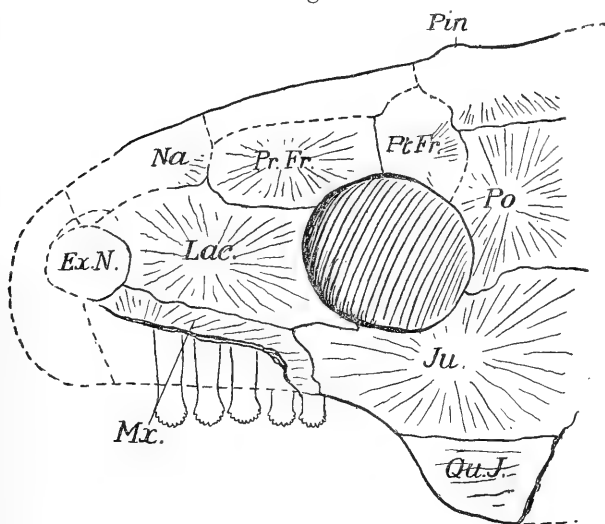
within the lachrymal just in front of the orbit, which reaches and articulates with the corresponding process on the upper surface of the palatine.

Septomaxillare.—Despite the fact that this bone has been described by Seeley and Broom, I can find no certain evidence of its presence, and believe that if it existed, as it probably did, it was only loosely placed in the nostril as in *Sphenodon* and most *Stegocephalia*.

Stapes.—A small fragment of bone lying in contact with the fenestra ovale on the right side of the Hottentots Rivier specimen, is probably the proximal end of a stapes; it is very imperfectly preserved, but seems to be a plain plug about 10 mm. across proximally, rapidly narrowing to 6 mm.

The only other types of Pariasaurian skull that are at my disposal are: 1st, the type skull of Owen's *Anthodon serraius*, and 2nd, the type skull of *Elginia mirabilis*.

Text-figure 7.



The type-skull of *Anthodon serraius* Owen, $\times \frac{1}{2}$.

The side of the face, showing the sutures.

This sketch should be compared with Owen's excellent lithographic drawing.

The skull of *Anthodon* is very badly preserved, being crushed, weathered, and all the surface removed from what bone remains; none the less it shows the sutures between the bones of the side of the skull quite clearly, they being indicated by the direction of the radiating fibres of the bones.

The structure will be most clearly understood from text-fig. 7.

The general plan of the structure is the same as in the larger and older South African *Pariasaurs*, but the more remarkable specializations of the latter types are absent; for example, the quadratojugal, though it does extend forwards below the jugal, does not reach the maxilla, and the lacrymal has a large exposure in the orbital margins. The quadrate is present in the specimen at the extreme hinder end of the part preserved.

General Discussion of the Skull.

Basis Cranii.—The occipital condyle is rather unusual in the great development of the pit for the anterior end of the notochord, which renders it on the whole concave; a similar condition occurs in *Diadectes* and *Limnoscelis* amongst early reptiles, and in a still more marked form amongst the primitive amphibia *Loxomma*, *Pteroplax*, etc. The condition is a primitive one.

The basisphenoid, except for its very great mass, agrees in its structure with that of most *Cotylosaurs*, having very powerful tubera and distinct basiptyergoid processes.

The parasphenoid, which is as usual indistinguishably fused with the basisphenoid, is of great length and touches the pterygoid in front as in *Labidosaurus*, *Seymouria*, and many other *Cotylosaurs*.

Brain-case.—The more remarkable features of the posterior part of the brain-cavity depend very largely on the fact that *Pariasaurus* is a large and very massively built animal. The great development of the supraoccipital region and its powerful fusion with the roof of the skull, so different from the conditions in such types as *Procolophon* and *Labidosaurus*, are probably produced in response to a mechanical necessity. The long, low, and wide form of the brain-cavity is a very remarkable feature which is not, so far as I know, paralleled by any other reptile.

The determination of the nerve-exits presents no difficulty, and the only unusual feature, the entrance of the VIIIth nerve into the ear on the anterior wall of the bony canal which forms the foramen jugulare, is, I believe, very largely dependent on the enormous size of the latter.

The ear, so far as can be seen, is of a very ordinary description, lying well up in the side wall of the brain-case.

It is apparently certain that the VIth nerve did not pierce the basisphenoid but must have issued through the prootic fissure.

Sphenethmoid.—The sphenethmoid was the name given by W. K. Parker to the small ring-shaped bone which surrounds the anterior part of the brain in the frog (Cuvier's *os en ceinture*).

In the frog it is a ring-shaped bone, ossified in the cartilage of the anterior part of the brain-case, and lying between the membrane-bones of the roof of the skull and those of the palate, particularly the parasphenoid, which it directly overlies. The whole bone in this animal lies in advance of the points of exit

of the optic nerves, but the olfactory nerves pass out in front of it.

A bone exactly corresponding to this in all its relations occurs in many Stegocephalia; it has been figured as a "Rhinencephalic chamber" by Williston in *Cacops* and *Aspidosaurus novomexicanus*, the latter specimen giving evidence from the fact that it is displaced, that it is not a downgrowth of the bones of the skull roof. By Fraas it has been figured but not determined or described in *Cyclotosaurus posthumus*, and it also occurs in some specimens of "*Bothriceps*" *huxleyi*.*

It is, however, much best shown in a skull in the Pretoria Museum found at Senekal, O. F. S., which is one of the specimens described by v. Hoepen as *Myriodon senekalensis*. In that specimen the roofing bones have been split away leaving the impression of their lower surface on the matrix, through an extremely thin and transparent film of which the upper surface of the sphenethmoid is clearly seen to be quite continuous over the brain. None of these specimens shows the distinction of the bone from the parasphenoid of which it might conceivably be an outgrowth; but a large and well-preserved skull apparently of a form very near to *Capitosaurus*, which I found on the farm Watford, Dist. Albert, Cape Colony, in the Cynognathus beds, shows the bone clearly, and it is extremely spongy, quite different from the hard membrane-bone of the parasphenoid.

No. 36358 in the British Museum is a fragment of a skull of *Capitosaurus nasutus*, Meyer, from Bernberg. It shows the right side of the face with the orbit, and on the back of the specimen part of the vertical plate of pterygoid which passes backward to the quadrate. In advance of this lies the sphenethmoid, only the right wall of which is preserved, and that with its inner surface destroyed so that the loose cancellar tissue is visible. The posterior end of the bone has a notch which presumably transmitted the optic nerve, and the anterior end is also notched. This bone is extremely clearly shown to rest in the deeply grooved upper surface of the parasphenoid.

This specimen affords conclusive evidence that the "rhinencephalic chamber" is a separate bone, for there can be no doubt of the interpretation of the present fragment, as the bone from its structure is obviously not the prootic, and also lies far in advance of the actual position of that bone in all known Stegocephalia. It is therefore certain that a bone surrounding the anterior part of the brain and separating the exits of the olfactory and optic nerves, which lies freely between the parasphenoid and the membrane-bones of the roof of the skull, occurs in many Temnospondylous and Stereospondylous Stegocephalia, and as it agrees exactly in all features with the sphenethmoid of the frog should be called by that name.

The bone which has been described above as surrounding the

* Since this was written Broom has described the sphenethmoid in *Eryops*.

anterior part of the brain in *Pariasaurus* differs from the sphenethmoid only in that its lateral walls are produced backwards so as to surround the exit of the optic nerve and reach the basi-sphenoid. In my opinion such a change, depending in the end solely on the degree to which ossification has proceeded, is not an important one, and we are thus justified in calling the bone in *Pariasaurus* also a sphenethmoid.

In the large Coal-measure amphibia such as *Pteroplax*, which I hold to be (in the wide sense) ancestral to both the Rachitomous and Stereospondylous Stegocephalia and the Cotylosauria, there is a great mass of bone, sheathing the front of the brain and passing forward as a septum nearly to the front of the head. From such a bone the sphenethmoid of *Pariasaurus*, like that of the later Stegocephalia, is easily derived by reduction. If this view be true, it will follow that W. K. Parker was essentially justified in identifying the pair of bones in the brain-case of Urodeles usually called "orbito-sphenoids" with the frog's sphenethmoid, for they also can be readily derived from the *Pteroplax* ethmoidal complex.

The bone is also interesting from the light it throws on the ethmoid of Therapsids. This bone has been carefully and excellently described by Prof. and Miss Sollas in *Dicynodon* and I know it well in *Endothiodon*, where it has an essentially similar structure. In this type it consists of a short, thick median septum which rests on the dorsal surface of the "vomer," which in Anomodonts is certainly composed of a pair of fused prevomers. This septum at the top and the back is split into two branches which form a covering to the olfactory nerves, which issue at the sides of the bone at about half its length, and are in front separated from one another by the septum reaching up to the roof of the skull. This bone is even more like the sphenethmoid of the frog than is that of *Pariasaurus*. There can be no doubt that it is homologous with the bone I described and called ethmoid in the skull of a Gorgonopsid.

Nor can there be any doubt in my opinion that the "mesethmoid" described in *Diademodon* by Dr. Broom and myself really represents the lower septal part of this bone, for it lies on the dorsal surface of the palate, above the vomer in some species and altogether in advance of it in the region of the palatines in others.

There can, I think, from a study of some models of a foetal skull of *Perameles* which Mr. R. W. Palmer was good enough to show me, be no doubt that this bone is correctly interpreted as the mammalian mesethmoid.

If this series of comparisons be justified, we shall have shown that the mesethmoid of a mammal, the ethmoid of Anomodonts, Gorgonopsids, and Cynognathids, the sphenethmoid of Batrachia, and the orbitosphenoids of Urodeles are all allied bones, and that they have all been derived from a condition resembling that

found in *Pariasaurus*, and in a more primitive form in *Pteroplax* and other Embolomorous Stegocephalia.

It may at some future time be possible to bring this bone into relation with the so-called alisphenoids of Crocodiles, which, as is already generally recognized, have nothing to do with the mammalian alisphenoid, but in the present state of our knowledge of the development of the crocodile skull it is unwise to institute such a comparison.

With regard to the identification of the nerve-exits little can be said. The large foramen is undoubtedly for the optic nerve, and the small foramen above it can only be for the trochlearius, its peculiar position being somewhat paralleled by a metamorphosing skull of *Rana temporaria* figured by Gaupp, fig. 372, Band iii. Hefte 2, of Hertwig's 'Handbuch der Entwicklungslehre.'

Palate.—The palate of *Pariasaurus* only differs from the primitive reptilian condition in the fact that the pterygoids extend forwards over the prevomers to reach the premaxillæ. I believe this unusual character to be an adaptive one. The whole palate of *Pariasaurus* is covered with a unique armature of small, sharply pointed teeth. The whole structure is such as to give very great strength to the roof of the mouth. The bone is thick, the middle line is raised into a ridge which forms a girder along the dorsal surface; in the prevomerine region this may be six centimetres deep; posteriorly the pterygoids are supported by the anterior end of the parasphenoid which, with the massive sphenethmoid above it, form a rigid connection between the palate and the roof of the skull. Finally, the palatine is supported about the middle of its area by the descending process of the prefrontal. The whole forms an assemblage of supports scarcely paralleled in any other type.

Squamosal.—The presence of only one bone in the temporal region makes it necessary to discuss which of the three bones of a primitive reptile has survived in *Pariasaurus*.

The relations of the quadrate in all Embolomorous, Rachitomous, and Stereospondylous Stegocephalia are in essentials identical, although they have seldom been accurately described, probably because they are usually best shown in broken and unpromising looking fragments. In all types of which I have been able to examine satisfactory material [*Pteroplax*, "*Loxomma*," "*Bothriceps*," *Micropholis*, *Capitosaurus*, *Trematosaurus*, *Batrachosuchus*, *Aphaneramma*, and others] the quadrate is a bone consisting essentially of a thick lower margin, provided with condyles for the articulation of the lower jaw, from which runs a thin plate which inclines more or less forwards. The posterior surface of this plate is covered to a greater or less degree by the posterior ramus of the pterygoid, which in later types is connected with a thin vertical wall rising nearly to the roof of the skull, and by the posterior edge of the outer and lower of the

temporal bones, the squamosal. In the majority of types the pterygoid and squamosal meet behind the quadrate, often in a long suture.

The other two bones never in my experience have any relation with either the quadrate or the pterygoid.

Dr. Broili's figures and descriptions of the type skulls of *Seymouria bayloriensis* show that that remarkable reptile is identical in the structure of the temporal region and the relations of the quadrate with such an amphibian as "*Loxomma*," a conclusion that I have verified by a personal examination of the Munich material.

The single temporal element in *Pariasaurus* is articulated with the outer edge of the quadrate and sends a process inward along its upper border, which in No. 49426 seems definitely to meet the posterior ramus of the pterygoid. Their relations are utterly different from those held by the upper two temporal bones in *Stegocephalia* and *Seymouria*, whilst they are very easily derived from those of the lower temporal element of these more primitive types by the reduction of the part of the squamosal which formerly covered the posterior surface of the quadrate.

It thus seems that we are justified in identifying the temporal element of *Pariasaurus* with the lower and outermost of the three of primitive *Cotylosaurs*.

This element is, I believe, the mammalian squamosal, a thesis which will be discussed in connection with the *Deinocephalian* skull.

One curious feature of the *Pariasaurus* squamosal, the projection of a flange of that bone behind the quadrate, is probably to be accounted for by supposing that the bone formerly finished at the quadrate, leaving a very large otic notch which was subsequently reduced to its actual minute dimensions by the production of the flange.

Systematic position and Relationship of Pariasaurus.

The first author who treated of the systematic position of *Pariasaurus* with the use of adequate material was H. G. Seeley in 1888. In that paper he reached the conclusion, very novel for its time, that *Pariasaurus* resembled Amphibia, Reptilia, and Mammals in different characters, and was intermediate between them. Although much of the evidence on which this conclusion was based has been shown to be incorrect, the conclusion itself remains remarkably near the truth.

All recent authors agree in placing *Pariasaurus* amongst the *Cotylosauria*, an attribution the meaning of which will now be discussed.

The Group *Cotylosauria* was founded originally on an erroneous interpretation of the character of *Diadectes*, which is the typical form of the group. As extended and used by all modern authors

it includes such types as *Seymouria*, *Diadectes*, *Procolophon*, *Captorhinus*, *Pariotichus* and *Pantylus*. These reptiles are extraordinarily different in many features, and those in which they agree are essentially primitive characters which they share with Temnospondylous Stegocephalia.

The group is in fact only held together by the following character, which separates it from other reptiles:—

The skull is completely roofed in the temporal region; every other feature in the skeleton can be matched in some or other early reptile.

Cotylosaurs are distinguished from the Temnospondylous Amphibia solely by the facts, that the intercentra are reduced and the neural arches are expanded and thickened and the zygapophysial articulating faces placed horizontally, and by the presence of only two bones in the proximal row of the tarsus (I believe this feature does occur in some small Stegocephalia which, as shown by the fusion of the hæmal arches to the centra in the caudal region, are quite unconnected with reptilian ancestry).

It is quite certain that the Reptilia, as a whole, must have been derived from a form with a roofed temporal region, for all known Carboniferous amphibia have this feature, and so also have all Palæozoic bony fish. Therefore this character, which alone separates and holds together the Cotylosaurs, is merely a primitive one. Whether all reptiles are derived from a cotylosaurian ancestor is not so certain; it is conceivable, though I do not regard it as at all probable, that some of them might be derived from amphibian types which had developed temporal vacuities. The fact that quite a number of early reptiles shew traces of the broad neural arches and horizontally placed zygapophysial facettes, which are on the whole the most characteristic of all the structures of the post cranial skeleton of Cotylosaurs, suggests strongly that these types at any rate, and of course their allies, have been derived from reptiles which, if we knew them, would be unhesitatingly called Cotylosaurs.

Seymouria stands apart from all other Cotylosaurs in the extraordinarily Stegocephalian appearance of its skull, its resemblance that is to the skulls of the majority of Temnospondyls and Stereospondyls, for it does not resemble more closely than those of other Cotylosaurs the skulls of the smaller Stegocephalia, the Branchiosaurs and "Microsaurs."

This resemblance depends on:—

1st. The shape of the skull.

2nd. The narrow otic notch placed high up so that the tabularia are fairly near to the middle line.

3rd. The fact that the quadrate slopes backwards so that its lower end lies far behind the upper.

4th. The upward direction of the opisthotics.

These four characters are really all connected, the presence of any one almost implies the others.

I do not think there can be much doubt that in these features

Seymouria has retained the structure of the most primitive reptiles.

If we consider later large Amphibia, we find that there is a tendency, which is repeatedly expressed, to replace the inclined quadrate by a vertical one; this is the case for example in *Butrachosuchus*, *Brachyops*, *Plagiosternum*, etc.

Exactly the same change takes place in Cotylosaurs. There are two extreme ways in which an inclined quadrate can be converted into a vertical one, either (a) the lower end is kept fixed and the upper end swung backwards, or (b) the reverse takes place.

The process (a) will result in a complete obliteration of the otic notch, and the squamosal will be brought into line with the tabular on the extreme back of the skull; this is probably the type of change which has produced such types as *Labidosaurus* and *Captorhinus*. In such types the tabulare, if it be present, being firmly fixed between the squamosal and the postparietal, does not really require any additional support, and the outer end of the opisthotic is free to wander down to the region of the quadrate condyle to render support to that bone.

The process (b) results in the retention of the otic notch and in fact in its exaggeration. To it we owe types like *Diadectes* and *Procolophon*, with an enormous otic notch overhung at the top by the squamosal and tabulare, and with the whole of the quadrate in advance of the basioccipital condyle. In these types the opisthotic is far removed from the quadrate and has no possible opportunity of supporting it.

From such a type *Pariasaurus* was undoubtedly derived by the subsequent obliteration of the otic notch, by the development of secondary plates from the squamosal and quadrato-jugal behind the quadrate. Even in these types the opisthotics have a tendency to rotate downwards, probably to extend the area for the attachment of neck muscles; in doing so they take the tabulars which are attached to their outer ends with them.

Another important type of change has been pointed out by v. Huene. This is that the postparietals and tabulares, which in *Stegocephalia* and *Seymouria* are bones on the upper surface of the skull, tend in later Cotylosaurs to be reduced to thin films placed vertically on the back of the skull. This change is a very important one.

We may now consider the relationship of *Pariasaurus* to such other Cotylosaurs as are sufficiently well known to make a comparison of any value.

Seymouria baylortiensis differs in the following characters, which are primitive ones:—

- (1) The shape of the skull.
- (2) The narrow otic notch.
- (3) The inclined quadrate.
- (4) The upwardly directed opisthotic.

- (5) The retention of three temporal bones.
 - (6) The primitive palate, identical in all important features with that of the primitive embolomorous Stegocephalia.
 - (7) The primitive humerus with a huge entepicondyle.
 - [(8) The single sacral rib. From the conditions found in carboniferous embolomorous Stegocephalia I am inclined to doubt if this is really primitive.]
 - (9) The ordinary pelvis.
 - (10) The expanded ribs.
- And in the following specialisations:—
- (11) The loss of the cleithrum.
 - (12) The loss of the posterior coracoidal element.

Diadectes and its allies differ considerably less from *Pariasaurus* than does *Seymouria* in most features, whilst they possess many advanced characters in which they differ from it more than does the latter type.

The only primitive features in which *Diadectes* differs from *Pariasaurus* are:

- 1. The retention of a supratemporal.
- 2. The expanded ribs.
- 3. The large entepicondyle of the humerus.
- 4. The simple pelvis.

Diadectes differs in the following advanced characters:—

- 5. The posttemporal vacuities are closed.
- 6. The postparietals and tabulares are placed more on the back of the skull than on the dorsal surface, so that they overlap the supraoccipital.
- 7. The common development of hypopophysial articulations.

The two types agree in many characters, for example:—

- 1. The concave basioccipital condyle.
- 2. The fact that the vertically placed quadrate is far forward.
- 3. The fact that the anterior part of the brain-case is surrounded by bone, which in *Pariasaurus* is a single sphenethmoid whilst in *Diadectes* it is said to be a paired "alisphenoid," but there is no doubt that the conditions are essentially similar.

These characters are all primitive ones.

There is in fact no doubt whatever that *Diadectes* and *Pariasaurus* are not in the least closely allied, but represent two lines differing fundamentally in the evolution of the brain-case, which in *Pariasaurus* is depressed and articulates with the roof of the skull only by a supraoccipital which is a solid narrow pillar separating large posttemporal vacuities and articulating with the lower surface of the parietal and postparietal; whilst in *Diadectes* the brain-cavity is high and the supraoccipital is expanded into a wide plate which is overlapped by the downturned postparietals.

It is difficult to compare *Pariasaurus* with *Limniscelis*, for no

description of the occiput has yet been published, and I am not sure that I understand rightly the figure of that region.

Apparently, however, that type resembles *Diadectes* in the closure of its posttemporal fossæ by the tabulares extending downwards to meet the whole of the opisthotic and supraoccipital border, and the supraoccipital is spread out into a wide plate. If this is so, the type can have no more than the most remote relationship to *Pariasaurus*.

Labidosaurus and *Captorhinus* resemble *Pariasaurus* in the loss of the temporal bones except the squamosal, and in the preservation of the posttemporal fossæ. They differ, however, completely in the primary loss of the otic notch, the bending down of the opisthotics till their outer ends are near the condyles of the quadrates, and in the placing of the postparietals vertically on the back of the skull. They also seem to differ in the loss of the sphenethmoid or any ossification of that character.

In the postcranial skeleton they differ in having lost the cleithrum, and in their curious humerus, which is quite different from that of *Pariasaurus*; and also in the presence of abdominal ribs and in the retention of an unspecialised pelvis.

Too little is known of *Pantylus* to make a comparison of any value.

I postpone any comparison with *Procolophon* until I describe that form.

In the foregoing comparisons I have laid great stress on the characters of the occiput and brain-case generally. I have done so because a study of this region in material representing nearly all the large groups of Reptiles and large Stegocephalia has convinced me that it is really one of the most important regions of the animal from a taxonomic standpoint.

It is in direct relation with the brain, and the general trend of palæontological thought seems to be tending to the view that the important part of evolution takes place in the brain, other characters following after. In addition this region houses the ear, and is far more removed from the action of external conditions than are such features as the palate and the temporal region. It is well known that in mammals the otic region and the base of the skull are of great importance in determining relationships for precisely this reason.

Since the time of Seeley most authors have felt that *Pariasaurus* might have some connection with Therapsid ancestry. This view was founded mainly on the extraordinarily mammalian appearance of the pelvis, where, although there is no pubo-ischiac

vacuity, the thrusting back of the acetabulum till it lies entirely behind the sacrum and the size of the latter, make the whole very mammalian; another feature in which this type resembles the Therapsids is the reduction of the phalangeal formula.

It is therefore necessary to compare the skull of *Pariasaurus* with that of a Therapsid; before doing so it will be convenient to discuss what are really the essential features of that great group.

The group Therapsida was founded by Broom to include all the South African reptiles which are admittedly closely related, *i. e.* the Anomodontia, "Cynodontia," "Therocephalia," Deinocephalia, and Dromasauria. It will be most convenient to see what characters are really common to all these types, then to discuss which of these characters are common also to other great groups of early reptiles which are admittedly not very closely related, and which features may be regarded merely as a primitive inheritance, and so to discover by elimination what characters are really diagnostic of the group. I have been able to examine satisfactory material of all the orders, that of the Dromasauria, which I only know through the kindness of Dr. Broom, being the least satisfactory in details of cranial structure.

The Deinocephalia are large reptiles of very massive structure. Skull with one temporal vacuity surrounded by the squamosal and postorbital (or by the same two bones with the parietal in addition?). No temporal bone except the squamosal. Temporal region short and pineal foramen far back. The occiput composed of a plate with very small laterally placed posttemporal fossæ, the supraoccipital overlapped by the vertically placed interparietal and tabulares, which are entirely on the back of the skull, and the latter of which reach down outside the posttemporal fossæ to the ends of the opisthotics. Brain-cavity very high. [Opening to inner ear placed low down?] Stapes in contact with the quadrate. Quadrate large, partially overlapped behind by the squamosal; a quadratojugal present. Palate not well known.

Septomaxillary present on the face; lachrymal not reaching septomaxillary.

Lower jaw with flat angular, with a notch on the lower border.

No intercentra behind the atlas; ribs double-headed throughout the presacral part of the column; four sacral vertebrae?

Two coracoidal elements, the anterior not contributing to the glenoid cavity.

Pelvis with a short vertically placed ilium; pubis and ischia meeting each other to form a plate-like pelvis.

Humerus of an expanded and twisted type, with an entepicondylar foramen.

[This description is founded on the British Museum material of *Tapinocephalus* and closely allied genera.]

ANOMODONTIA. (*Dicynodon* etc.)

The Anomodonts are small to large reptiles of semi-crawling gait and herbivorous diet. There is one temporal vacuity surrounded by the postorbital and squamosal, or the same bones with the jugal in addition. No temporal bone except the squamosal. Temporal region short, pineal foramen not very far back, a pre-parietal present.

Occiput composed of a plate with small laterally placed post-temporal vacuities. Supraoccipital overlapped by the vertically placed interparietal [and tabulares when present.] Brain-cavity very high. Opening to inner ear placed very low down. Stapes in contact with the quadrate. Quadrate small, almost completely overlapped behind by the large triradiate squamosal. Quadrato-jugal present, but almost invariably fused with the quadrate. Palate with large pterygoids, meeting below the basisphenoid, then separating so as to leave a large interpterygoid vacuity, reaching forward to the prevomers. Prevomers—fused, separating the posterior nares, a rudimentary secondary palate formed by maxillæ and palatines. Transverse present or not. Parasphenoid a long, thin vertically placed plate forming a rostrum to the basisphenoid and extending forward over the interpterygoid vacuity to the prevomers (? in all types). Teeth on the maxilla only, sometimes absent. Septomaxillary always present, sometimes in the nostril, sometimes on the face; lachrymal meeting or not meeting the septomaxillary. Lower jaw with flat angular, with a deep notch overlung by a reflected lamina. 25–28 presacral vertebræ; no intercentra behind the atlas. Ribs double-headed in front, single-headed behind. Sacrum of four to seven vertebræ. Tail short. In shoulder-girdle—scapula with strong acromion, two coracoidal elements, the anterior excluded from the glenoid cavity. Clavicles and broad flat interclavicle always, cleithrum sometimes present. Humerus short, broad, twisted, with an entepi- and sometimes ectepicondylar foramina. Carpus with two centralia and five distal carpals, sometimes unossified; formula of phalanges 2, 3, 3, 3, 3. Pelvis with a large ilium, small pubis and ischia, with a pubo-ischiadic vacuity, sometimes no symphysis between the two halves. Femur long and comparatively slender; two proximal and four distal tarsals and one centrale. Five digits in pes, formula 2, 3, 3, 3, 3 usually, sometimes with additional phalanges in 3rd and 4th toes.

It will be convenient to treat the “Therocephalia” and “Cynodontia” together, as the two groups in a wide sense stand in the relation of parent and child.

Small to large reptiles of carnivorous habit, semi-crawling to thoroughly cursorial.

Skull with a single temporal vacuity (? traces of another in *Cynognathus*) bounded by the postorbital and squamosal, sometimes with the parietal and jugal in addition. Only a squamosal of the temporal elements. Temporal region short to fairly long.

Pineal foramen far back to far forward. Occiput composed of a plate with small laterally placed post-temporal vacuities; supra-occipital overlapped by the vertically placed interparietals and tabulares, which reach down to the opisthotics. Brain-case very high; opening to inner ear placed very low down. Stapes in contact with quadrate. Quadrate small to very small, almost completely overlapped behind by the squamosal. Quadratojugal usually absent, but sometimes represented by a rudiment. Palate very variable, showing the gradual development of a mammalian type from an almost typical primitive reptilian palate. (It is completely known in very few types.)

Septomaxillary always present on the face or in the nostril.

Lower jaw with flat angular, with a deep notch overlaid by a reflected lamina, which becomes rudimentary in later forms.

About 28 presacral vertebræ, three or four sacrals. Inter-centra in the front part of the column. Ribs double-headed in front, single-headed behind.

Scapula with or without an acromion. Two coracoidal elements, the anterior excluded from the glenoid cavity, clavicles and broad flat interclavicle always present, cleithrum present or absent.

Humerus short and expanded to long and very slender, always twisted; entepi- and ectepicondylar foramina always? present.

Carpus (only few types) with two centralia and five distalia. Five digits; formula 2, 3, 4, 5, 4, later reduced to 2, 3, 3, 3, 3.

Pelvis without a pubo-ischiadic vacuity in early types, with one in later forms.

DROMASAURIA. (*Galecheirus*, etc.)

Small arboreal reptiles with long slender limbs.

Skull short, with one temporal vacuity bounded by the squamosal and postorbital and ? jugal. Pineal foramen far back. Preparietal present (?). Occiput very badly known but apparently very similar to that of a Deinocephalian. Ear and brain-cavity unknown. Quadrate unknown. Quadratojugal probably absent. Palate unknown. Lower jaw with large dentary and apparently flat notched angular.

Tail very long.

Scapula without acromion, two large coracoidal elements. Clavicles and broad flat interclavicle.

Humerus long, very slender, and twisted.

Carpus with two centralia; digital formula 2, 3, 3, 3, 3.

Pelvis with small upright ilium and large plate-like pubis and ischium.

Femur very long and slender. Tarsus with two proximal and four distal tarsals and one centrale. Digital formula 2, 3, 3, 3, 3.

Comparison of these short descriptions will show that the only features which are of any importance* in which the five great groups agree are :—

1. There is one lateral temporal vacuity.
[The material suggests that in primitive types this was bounded by the postorbital and squamosal alone, and is hence not homologous with either of those of *Sphenodon*.]
2. There is only a squamosal in the temporal region.
3. The occiput is plate-like, the supraoccipital being broadened to a wide flat plate, which separates very widely the small posttemporal vacuities.
4. There is a single interparietal formed by a fused pair of postparietals, which, with the tabularia which are usually present, is placed entirely on the back of the skull and overlaps the supraoccipital.
5. The brain-cavity is very high.
6. The opening from the brain-cavity to the ear is very low down.
7. The stapes articulates with the quadrate.
8. The angular is flat and notched.
9. The interclavicle is always flat and wide, not T-shaped.
10. There are two coracoidal elements.
11. The anterior coracoidal element does not contribute to the glenoid cavity,
12. There are always two centralia and five distal carpals when the carpus is well ossified.
13. There are always two proximal and four distal tarsals and one centrale when the tarsus is well ossified.

Of these characters, which include all common to all South-African Therapsids that are likely to be of taxonomic importance, Nos. 9 & 10 are merely primitive features, and so in all probability are 12 & 13.

In fact, the characteristic features of the Therapsids, which show the real individuality of the group, are those numbered 1-8. Numbers 3-6 are really so connected as to be essentially one character, and with the condition of the angular and stapes are the only features which we could hope to recognise in a *Cotylosaurian* ancestor.

It will be found that all these characters, except the exclusion of the anterior coracoidal element from the glenoid cavity, and the occasional presence of a vestigial supratemporal in the temporal region, occur in the various American types which have been included in the *Pelycosauria*.

Dimetrodon, for instance, has a single temporal vacuity, its

* They, of course, agree in such characters as the presence of parietals, prefrontals, lachrymals, etc.

occiput is plate-like with a wide supraoccipital separating the posttemporal fossæ. Any bones which could be postparietals or tabulares are on the posterior surface overlapping the supraoccipital, the brain-cavity is very high, and the ear, as shown extremely well by the "brain-cast" figured by Case, is very low in the skull.

The angular is flat and notched; there are two coracoidal elements, the interclavicle is flat and wide and not T-shaped, and the carpus and tarsus are of thoroughly Therapsid type. In fact, every character that is found in all South-African Therapsids is also present in *Dimetrodon*, which must hence be included in the same group. [It is, however, much more primitive than any South-African type in many features.]

With *Dimetrodon*, *Edaphosaurus* must go to the Therapsids, for it also has the characteristic occiput and angular.

Varanosaurus, as shown by the magnificent type-specimen of *V. acutirostris* in Munich, has an occiput of the same type, although of course it is very incompletely known. Unfortunately the angular of this type is completely unknown; the form has, however, the two coracoidal elements, shown extraordinarily clearly in the Munich specimen, a flat and not T-shaped interclavicle, and, as shown by Williston's excellent description, the feet only differ by lack of ossification of centralia. It can, I think, also be regarded as a Therapsid.

When one comes to *Ophiacodon* the problem becomes much more difficult. The whole of the post-cranial skeleton of that type, as described by Williston and Case, seems to be essentially identical with *Varanosaurus*, but the extraordinary skull with two temporal vacuities is apparently very different. It is exceedingly unfortunate that no description of the occiput or lower jaw is possible, and, in my opinion, in the absence of that knowledge, we are not justified in discussing the position of *Ophiacodon* amongst primitive Reptilia.

The foregoing discussion will, I hope, have made clear what, in my opinion, are the really important characters of the Therapsids; it remains only to examine *Pariasaurus* in the light of them.

It shares with the Therapsids the possession of two coracoidal elements and a single squamosal bone. The occiput is not in the least plate-like, the postparietals and tabulares are quite on the upper surface of the skull, the brain-cavity is long and low, the opening from the brain-cavity to the inner ear is high on the side-wall of the brain-cavity, the angular is boat-shaped, and the internal mandibular vacuity, which, by its excessive enlargement, gives rise to the flat Therapsid angular, is extremely small; the interclavicle is T-shaped and narrow; there are no centralia on the carpus or tarsus, and the proximal tarsals are fused.

It is thus certain that so far from being at all closely related to the Therapsids, *Pariasaurus* represents an extremely different

branch of the early reptile stock, any resemblance which it bears to them being simply due to convergence.

I wish to express my thanks to Drs. A. Smith Woodward and C. W. Andrews for much help during my work at the Natural History Museum, and to Herren Prof. F. Broili in München and Prof. F. v. Huene in Tübingen, who allowed me to work over the fine series of Texas "Permian" vertebrates in the museums of their respective Universities. Finally, I have to thank the Percy Sladen Trustees, who assisted me to visit South Africa, and especially G. Gordon, Esq., the owner of Hottentots Rivier, to whose hospitality and interest I owe the specimen of *Pariasaurus* which forms the basis of this paper, and Mr. R. Hall of the British Museum, to whose skill and care as a preparator our detailed knowledge of *Pariasaurus* is very largely due.

11. Report on the Deaths which occurred in the Zoological Gardens during 1913, together with a list of the Blood-Parasites found during the Year. By H. G. PLIMMER, F.R.S., F.Z.S., Pathologist to the Society.

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On January 1st, 1913, there were 826 mammals, 2162 birds, and 486 reptiles in the Zoological Gardens; and during the year 446 mammals, 1356 birds, and 683 reptiles were admitted, making a total for the year of 1272 mammals, 3518 birds, and 1169 reptiles.

During 1913, 356 mammals, 857 birds, and 467 reptiles have died: that is, a percentage of 27·9 for mammals, 24·3 for birds, and 39·4 for reptiles.

Out of the total deaths for the year, 1680 in all, 723 occurred in animals which had not been six months in the Gardens: that is nearly half the total number. It has been found that after six months' residence in the Gardens, the death-rate falls rapidly; so that it is assumed that by that time the new animals have got over their journeys, or have died from any diseases they may have brought with them, or have got quite used to their new environment. Of these 723 animals, 141 were mammals, 277 were birds, and 305 were reptiles; and if these be deducted from their respective totals the death-rate will appear as 16·9 per cent. for mammals, 16·4 per cent. for birds, and 13·8 per cent. for reptiles.

The following Tables show the facts which have been ascertained, in outline. Table I. summarizes the actual causes of death in the three groups specified. Under Reptiles are included Amphibia and a few Fishes.

TABLE I.—Analysis of the Causes of Death.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
1. <i>Microbic or Parasitic Diseases.</i>				1
Tuberculosis	31	104	6	2
Mycosis	8	75	1	3
Pneumonia	34	89	138	4
Septicæmia	1	...	...
Abscess	1	...	...
Pericarditis	1	1	...	
Peritonitis	5	1	...	
Empyema	6	...	...
Stomatitis .....	...	...	1	
Pylephlebitis	2	...	...	5
Hydatids	1	...	...
Worms .....	...	...	2	

TABLE I.—Analysis of the Causes of Death (*continued*).

Disease.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
<i>2. Diseases of Respiratory Organs.</i>				
Tracheitis .....	...	1	...	} 6
Broncho-pneumonia	25	...	...
Bronchitis	6	...	...
Congestion of lungs	14	98	13	
Atelectasis	1	...	...
<i>3. Diseases of the Heart.</i>				
Pericarditis .....	...	3	...	7
Degeneration of heart-muscle ..	1	1	...	
<i>4. Diseases of the Liver.</i>				
Hepatitis .....	...	3	...	
Fatty degeneration .....	...	4	...	
Cirrhosis .....	...	1	...	
<i>5. Diseases of the Alimentary Tract.</i>				
Gastritis	3	2	1	8
Gastric ulceration	4	...	2	
Gastro-enteritis	7	...	9	} 9
Enteritis	33	148	15	
Intestinal obstruction	2	2	...	10
Intussusception	3	...	...
Strangulated intestine	1	...	...	11
Perforation of intestine	1	...	...
Prolapse of rectum (sloughing) ..	1	...	...
Perforation of proventriculus ...	...	1	...	
<i>6. Diseases of Urinary and Generative Organs.</i>				
Nephritis	90	135	6	12
Cystic kidneys .....	...	...	1	13
Stone	1	...	...	14
Inflamed oviduct .....	...	6	...	
Retained placenta	1	...	...
<i>7. Various.</i>				
Sarcoma	4	1	...	15
Myelitis	1	...	...
Injuries discovered <i>post-mortem</i> }	7	9	1	

Besides those tabulated above,

44 mammals, 127 birds, 4 reptiles, were killed by order or by companions,

3 „ 11 „ 178 „ died from malnutrition or starvation,

8 „ 36 „ 85 „ were too decomposed for examination,

these completing the total.

In Table I. a classification is made of those diseases which actually caused death, but in most cases the animals were suffering from other diseases as well. Table II. summarizes those other

diseases from which the animals were suffering; and if this Table be taken in conjunction with Table I., a much more accurate estimate of the amount of disease in the Gardens will be arrived at.

TABLE II.—Other Diseases found in the animals tabulated in Table I.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
Tuberculosis	3	11	...	16 17 18 19 20 21
Mycosis	4	4	2	
Pneumonia	4	3	7	
Pericarditis	2	...	...
Peritonitis	10	...	...
Abscess	4	...	3	
Empyema	2	...	...
Septicæmia	1	...	...
Stomatitis .....	...	...	7
Malaria .....	...	18	1
Filaria	10	28	...	
Hæmogregarines .....	...	...	35
Trypanosomes .....	...	6	...
Worms .....	...	5	9
Hydatids	4	...	...
Sarcocystis	1	...	...
Leucocytozoa .....	...	3	...
Pyorrhæa	2	...	...
Bronchitis	9	1	...	22
Broncho-pneumonia	4	...	...
Congestion of lungs	24	114	9	
Edema of lungs	1	84	10	
Emphysema	2	...	...
Hydrothorax	2	...	...
Pleuritis	1	...	...
Pericarditis .....	...	10	...
Fatty heart .....	...	2	1
Dilated heart	4	2	...	
Atheroma	5	6	...	
Hepatitis	1	6	2	
Cirrhosis of liver	2	5	...	
Fatty liver	16	70	9	
Gastritis	2	1	...	
Gastric ulceration	14	...	...
Gastro-enteritis	2	...	2	
Intussusception	1	...	...
Intestinal obstruction .....	...	1	1
Enteritis	22	84	23	
Nephritis	63	70	5	
Cystic kidneys	1	...	...
Cystitis	5	...	...
Inflamed oviduct .....	...	1	...
Rickets	7	1	...	
Malnutrition	4	7	5	
Ascites	1	2	1	
Injuries	5	9	...	

Table III. shows, in still further detail, the distribution of diseases amongst the various orders of mammals.

TABLE III.—The Distribution of Diseases causing Death amongst the principal Orders of Mammals.

Diseases.	Primates.	Carnivora.	Rodentia.	Ungulata.	Edentata & Insectivora.	Marsupialia.
Tuberculosis	16	5	9	1	...	...
Mycosis .....	...	...	1	1	...	6
Pneumonia	10	6	13	2	...	3
Abscess .....	...	1	...	...	...	...
Pylephlebitis .....	...	...	...	2	...	...
Empyema	1	2	1	1	...	1
Pericarditis .....	...	...	...	1	...	...
Peritonitis .....	...	2	1	1	...	1
Hydatids	1	...	...	...	...	...
Septicæmia .....	...	1	...	...	...	...
Bronchitis	3	...	1	1	1	...
Broncho-pneumonia	8	6	3	6	1	1
Congestion of lungs	6	...	5	2	1	...
Atelectasis .....	...	...	...	1	...	...
Fatty heart .....	...	...	...	...	1	1
Gastritis .....	...	...	...	2	1	...
Gastro-enteritis	2	1	3	...	...	1
Intestinal obstruction .....	...	2	...	...	...	...
Perforation of intestine .....	...	...	...	1	...	...
Gastric ulceration	2	...	2	...	...	...
Strangulation of intestine .....	...	1	...	...	...	...
Sloughing intestine .....	...	1	...	...	...	...
Intussusception .....	...	2	...	...	...	1
Enteritis	9	9	7	6	2	...
Nephritis	20	31	13	12	3	10
Stone .....	...	...	...	1	...	...
Sarcoma	1	1	2	...	...	...
Myelitis .....	...	1	...	...	...	...

Notes on the foregoing Tables.

1. The total incidence of infectious diseases in the Gardens is about 7 per cent. for mammals and birds and 12 per cent. for reptiles.

2. There has been an increase in the deaths from tubercle amongst the mammals and birds. In the former it was due to an epidemic which broke out in the old Insect House in 1912: 15 of the 31 cases in mammals came from this House. 13 of the 31 mammals had not been in the Gardens for six months, and 4 of them had been pet animals. The most interesting case was that of an Ibex under one month old, which had tubercle in one lung and in the thymus: there was scarcely any healthy tissue

left in the latter organ. In the case of a Bear the disease was of human type. Most of the cases in birds would appear to have been acquired in the Gardens, as only 22 of them had been less than six months in the Gardens. In 61 of the birds it was acute, and was a general infection: in 11 it was of bovine type. 4 of the reptiles, which show a considerable decrease, were tortoises.

3. All the mould-diseases have been grouped under mycosis. Of the 8 mammals, 6 were Kangaroos and the disease was of the same type as that previously described, 1 was in a Gazelle, of same type, and the other was a mycotic disease of the intestine in a Beaver, in which the mould was of a different variety. The number of deaths from mycosis in birds is still very high, and constitutes 8·7 per cent. of the deaths in birds. Some young Pheasants died from mycosis at the age of 14, 17, and 20 days, with mycotic growth in all the organs and filling the body-cavities.

4. There has been a slight decrease in the incidence of pneumonia in mammals and birds, and a slight increase in reptiles. In 5 of the latter it was due to irritation caused by worm eggs; the rest were pneumococcal and constitute about 30 per cent. of the number of deaths in reptiles.

5. In umbilical veins of recently born Buffalo and Gnu.

6. There has been a general decrease of these diseases of the respiratory organs: they are largely dependent on weather.

7. These cases of pericarditis in birds were not due to infection, but to a deposit of crystals in the pericardium associated with chronic kidney disease.

8. The two birds were Penguins, in which over-distension with fish was the cause.

9. In 6 of the mammals, 14 of the birds, and 3 of the reptiles the inflammation was caused by parasites (worms and coccidia). In 1 of the mammals and 7 of the birds the cause was a traumatic one (sand, hay, etc.). In 7 of the mammals and 65 of the birds it was hæmorrhagic, and probably of bacterial origin. The remainder of the cases were apparently due to the quantity or quality of the food not being suitable to the animal.

10. Two of these bad intussusceptions were in Genets.

11. In a Plover from wire.

12. There has been a slight increase in the number of cases of nephritis. Under this are grouped the acute and chronic cases, many of the latter being the result of old age. 14 of the cases in mammals were acute, and 32 of the cases in birds: the rest were of varying degrees of chronicity. Many of the mammals and birds had associated lung lesions, which would seem to indicate that climatic conditions and exposure may be answerable for these cases.

13. In a Terrapin in which both kidneys were converted into multiple cysts.

14. In an Antelope in which a stone impacted in the urethra had produced a ruptured bladder.

15. Two of these were lympho-sarcomata of the abdominal glands in two sheep, mother and son, from the same house. The others were an angiosarcoma of liver in a Coypu rat, a sarcoma of the scalp in a Cercopitheque, and an adeno-sarcoma in a Rail.

16. The diseases grouped under the term malaria were due in 12 instances to *Hemoproteus danilewskyi* and in 6 instances to *Plasmodium præcox*.

16, 17, 18, 19, 21. See the section on blood-parasites below.

20. This was a very considerable infection of the muscles of a Langur, which was not visible to the naked eye.

22. There has been a considerable decrease in the number of rickety mammals.

In comparing the deaths recorded in this Report with those of the five preceding years, there are two points which seem to be in continual prominence, and which must therefore be of practical importance. The one is the fact that a large number of animals—in the large sense—nearly half of the total number, have died within six months from their admission to the Gardens, the majority of these dying within three months. Of these, a large number die of microbic or parasitic diseases.

The other fact is that a very large percentage of animals have died from inflammatory conditions of the alimentary tract which cannot be attributed to mechanical or microbic causes, and which are apparently due to some defect in their food, the quality or quantity or both not being suitable to the animal.

From a consideration of these facts, it would seem possible that the point first mentioned could be dealt with practically by a proper and effective quarantine, which would prevent the introduction into the Gardens of new infections, or of those already existing there, in a condition of increased virulence.

As regards the cases next mentioned, a careful consideration by experts of the feeding of the animals throughout the Gardens, would enable reasonable and physiological alterations to be made, and probably would reduce effectively the death-rate from this cause.

BLOOD-PARASITES.

During the year the blood of every animal which died has been examined, with the result that parasites have been found in 138; in 60 species for the first time.

They have been distributed as follows:—

Filariae. In 5 mammals; found in 3 species for the first time.

28 birds; in 20 species for the first time.

5 reptiles; in 1 species for the first time.

Trypanosomes. In 8 birds; in 5 species for the first time.

2 reptiles.

<i>Malaria.</i>	{	<i>Hæmoproteus danilewskyi.</i>	In 14 birds; in 7 species for the first time.
		<i>Plasmodium præcox.</i>	In 6 birds; in all for the first time.
		<i>Hæmocystidium.</i>	In 1 reptile.
<i>Leucocytozoa.</i>		In 4 birds; in 2 species for the first time.	
<i>Hæmogregarines.</i>		In 64 reptiles; in 14 species for the first time.	
<i>Intestinal organisms of</i>		}	In 1 reptile for the first time.
<i>Hexamitus type.</i>			

The following Tables show the occurrence of the blood-parasites in detail :—

Embryo Filarie found in the blood of Mammals.

	HABITAT.	TYPE OF FILARIA.
2 Lion Marmosets (<i>Leontocebus rosalia</i>).	Brazil.	Long.
<i>Found in the following for the first time :</i>		
Short-tailed Wallaby (<i>Macropus brachyurus</i>).	Australia.	Long, thick, very pointed.
Rock Wallaby (<i>Petrogale penicillata</i>)...	Australia.	Long, thick.
Martin's Cercopitheque (<i>Cercopithecus martini</i>).	W. Africa.	Long.

Embryo Filarie found in the blood of Birds.

White-throated Jay Thrush (<i>Garrulax albigularis</i>).	India.	Short, thick, no vacuole.
Lanceolated Jay (<i>Garrulus lanceolatus</i>).	India.	Short, pointed.
Brazilian Hangnest (<i>Icterus jamaicai</i>)...	Brazil.	Long, no capsule.
Mexican Jay (<i>Xanthura luxuosus</i>)	Mexico.	Long, pointed.
Wood Thrush (<i>Turdus mustelinus</i>)	N. America.	Short, pointed.
<i>Found in the following for the first time :</i>		
Albert Towhee (<i>Pipilo alberti</i>)	N. America.	Short, thick.
Rose Finch (<i>Carpodacus erythrinus</i>) ...	India.	Long.
Black Bullfinch (<i>Melanopyrrha nigra</i>) .	Cuba.	Long, pointed.
Black Francolin (<i>Francolinus vulgaris</i>).	India.	Long.
Mexican Rose-Finch (<i>Carpodacus mexicanus</i>).	Mexico.	Long.
Black-shouldered Tanager (<i>Calliste melanonota</i>).	Brazil.	Short, thick.
Mahali Weaver-bird (<i>Plocepasser mahali</i>).	S. Africa.	Short, pointed.
Nuthatch (<i>Sitta cinnamomeiventris</i>) ...	India.	Long, thick.
Chestnut-bellied Nuthatch (<i>Sitta castaneiventris</i>).	India.	Long, pointed.
Pileated Song Sparrow (<i>Zonotrichia pileata</i>).	S. America.	Short.
Cuban Amazon (<i>Chrysotis leucocephala</i>).	Cuba.	Short, thick, pointed.
Red-shouldered Starling (<i>Agelæus phœniceus</i>).	N. America.	Short, pointed.
Sulphury Tyrant (<i>Pitangus sulphuratus</i>).	S. America.	2 kinds; one very long, the other very short and thick.

Great Grey Shrike (<i>Lanius excubitor</i>) ...	Europe.	No capsule, very striated.
Swainson's Blue Jay (<i>Aphelocoma sor- dida</i>).	Mexico.	Short.
Red-billed Hornbill (<i>Lophoceros erythro- rhynchus</i>).	Africa.	Short.
3 Indian Rollers (<i>Coracias indica</i>)	India.	Short.
2 White-headed Starlings (<i>Poliopsar leucocephalus</i>).	China.	Long.
Larger Hill-Mynah (<i>Gracula inter- media</i>).	India.	Short, thick, and pointed.
Malaccan Parrakeet (<i>Palæornis longi- cauda</i>).	Malacca.	Long.

Embryo Filariae found in the blood of Reptiles.

Edible Frog (<i>Rana esculenta</i>)	Europe.	Short, thick.
2 Say's Snakes (<i>Pituophis sayi</i>)	N. America.	Long.

Found in the following for the first time :

2 Warty Chameleons (<i>Chamæleon verru- cosus</i>).	Madagascar.	Short, stout, with thick capsule.
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Trypanosomes found in the blood of Birds.

2 Blue-crowned Hanging Parrakeets (<i>Loriculus galgulus</i>).	Malay.
Little Owl (<i>Athene noctua</i>)	Europe.

Found in the following for the first time :

Goldfinch (<i>Carduelis elegans</i>)	N. Europe.
Shama (<i>Cittocincla macrura</i>)	India.
Tawny Owl (<i>Syrnium aluco</i>)	Europe.
Spotted-sided Finch (<i>Steganopleura gut- tata</i>).	Australia.
Brazilian Hangnest (<i>Icterus jamaicæ</i>) .	Brazil.

These were all of the type of *Trypanosoma avium*.

Trypanosomes found in the blood of Reptiles.

Tree-Frog (<i>Hyla arborea</i>) (blue variety).	S. Europe.
Edible Frog (<i>Rana esculenta</i>)	S. Europe.

These were of the type of *Trypanosoma rotatorium*.

*Intestinal Organism found in the Blood of the following Reptile
for the first time.*

Rough Terrapin (<i>Nicoria punctularia</i>) .	S. America.	Of Hexamitus type.
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Hæmogregarines found in the blood of Reptiles.

3 King-Snakes (<i>Coronella getula</i>)	N. America.	Small, short.
3 Rat-Snakes (<i>Zamenis mucosus</i>)	India.	Medium sized.
Reeves's Terrapin (<i>Damonia reevesi</i>) ...	China.	Small, short.
2 Bushmasters (<i>Lachesis mutus</i>)	Trinidad.	Large, host-cells enlarged and de hæmoglobinised.
3 Cobras (<i>Naia tripudians</i>)	India.	Long.
3 Dark Green Snakes (<i>Zamenis gemon- ensis</i>).	S. Europe.	Small, host-cells enlarged.

Diamond Python (<i>Python spilotes</i>)	Australia.	Large.
Blood-stained Terrapin (<i>Cinosternum cruentatum</i>).	S. America.	Long.
3 Hog-nosed Snakes (<i>Heterodon platyrhinos</i>).	N. America.	Large, host-cells enlarged.
8 Common Boas (<i>Boa constrictor</i>)	S. America.	Large, host-cells enlarged.
Eyed Lizard (<i>Lacerta ocellata</i>)	S. Europe.	Long, host-cells enlarged.
5 Rattlesnakes (<i>Crotalus atrox</i>)	N. America.	Large, host-cells enlarged.
3 Testaceous Snakes (<i>Zamenis flagelliformis</i>).	N. America.	Long, host-cells enlarged and de hæmoglobinised.
3 Indian Pythons (<i>Python molurus</i>)	India.	Medium, cells deformed.
Anaconda (<i>Eunectes marinus</i>)	S. America.	Long, doubled over.
4 Say's Snakes (<i>Pituophis sayi</i>)	N. America.	Long, host-cells enlarged.
Vivaceous Snake (<i>Tarbophis fallax</i>)	S. Europe.	Medium.
Gallot's Lizard (<i>Lacerta galloti</i>)	N. Africa.	Of Karyolysus type.

Found in the following for the first time :

3 Pigmy Rattlesnakes (<i>Sistrurus miliarius</i>).	N. America.	Small.
Spinose Land-Emys (<i>Geoemyda spinosa</i>).	Malay.	Medium.
Helen's Snake (<i>Coluber heleni</i>)	Ceylon.	Small.
Banded Trichogaster (<i>Trichogaster fasciatus</i>).	India.	Short and thick; of interest, as they are said not to occur in fresh-water fishes.
Bengal Monitor (<i>Varanus bengalensis</i>)...	India.	Large, of ordinary type.
Cape Viper (<i>Causus rhombeatus</i>)	S. Africa.	Of Drepanidium type; nearly every corpuscle infected.
Four-lined Chicken Snake (<i>Coluber obsoletus</i> , var. <i>quadrivittatus</i>).	N. America.	Large.
2 Emerald Green Tree-Snakes (<i>Gastrophys smaragdina</i>).	Sierra Leone.	Long, doubled over; host-cells enlarged.
Graham's Snake (<i>Zamenis grahami</i>)	N. America.	Large, host-cells enlarged.
Harlequin Elaps (<i>Elaps fulvius</i>)	N. America.	Large and doubled over.
Long-nosed Crocodile (<i>Crocodilus cataphractus</i>).	N. Nigeria.	Some short and thick, others long and doubled over.
Leopardine Snake (<i>Coluber leopardinus</i>).	S. Europe.	Small and thin.
Cananina Snake (<i>Phrynonax sulphureus</i>).	Trinidad.	Large, host-cells enlarged.
Sooty Snake (<i>Boodon fuliginosus</i>)	W. Africa.	Large, host-cells enlarged and de hæmoglobinised.

Hæmoproteus danilewskyi found in the blood of Birds.

HABITAT.

2 Blue-crowned Hanging Parrakeets (<i>Loriculus galgulus</i>)	Malay.
Kestrel (<i>Tinnunculus alaudarius</i>)	Europe.
Eagle Owl (<i>Bubo maculosa</i>)	S. Africa.
3 Indian Rollers (<i>Coracias indica</i>)	India.

Found in the following for the first time :

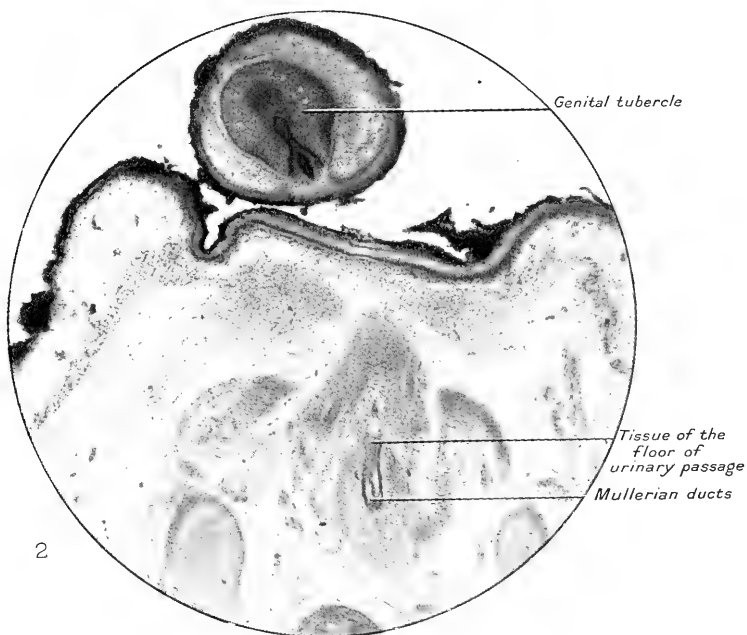
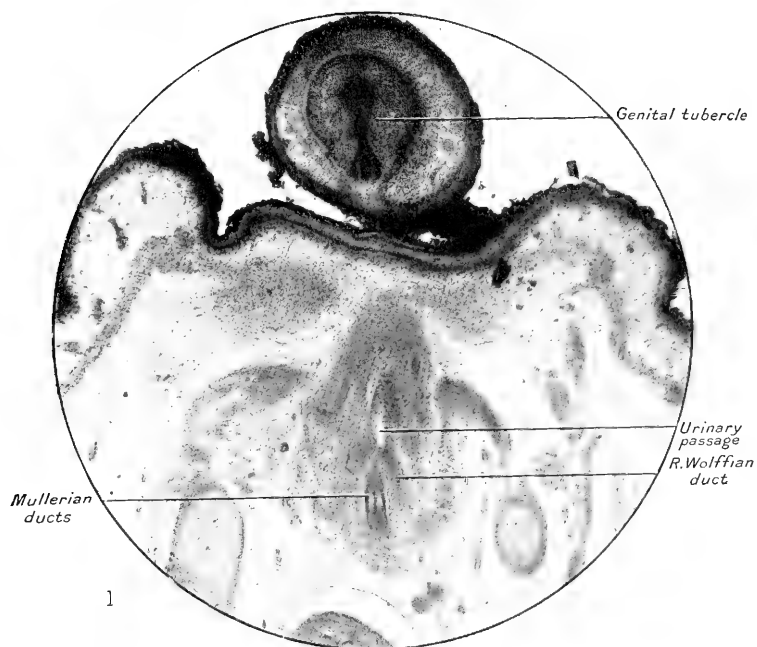
Malayan Peacock-Pheasant (<i>Polyplectrum bicalcaratum</i>)	Malay.
Shama (<i>Cittocincla macrura</i>)	India.
Siskin (<i>Chrysomitris spinus</i>)	N. Europe.
Tawny Owl (<i>Syrnium aluco</i>)	Europe.
Lanceolated Jay (<i>Garrulus lanceolatus</i>)	India.
Sulphury Tyrant (<i>Pitangus sulphuratus</i>)	S. America.
Lesser Kestrel (<i>Tinnunculus cenchris</i>)	S. Europe.

Plasmodium præcox found in the blood of Birds:

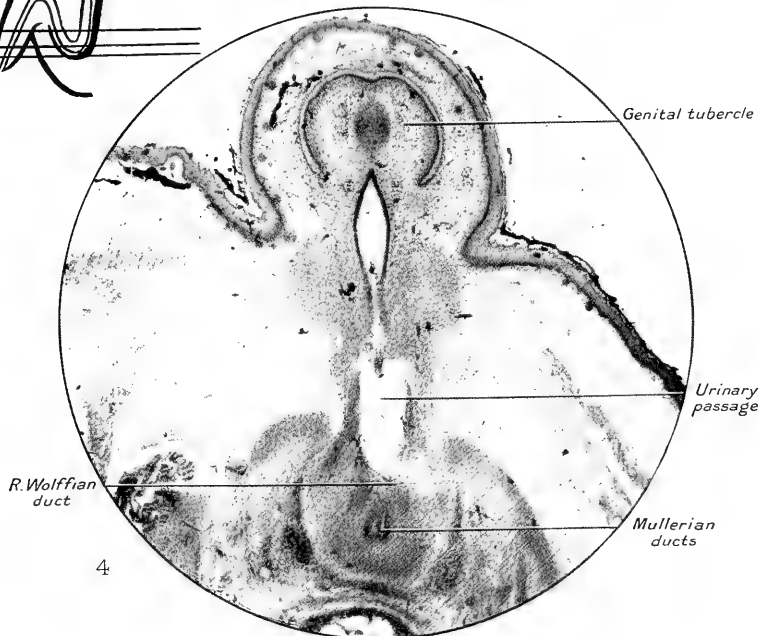
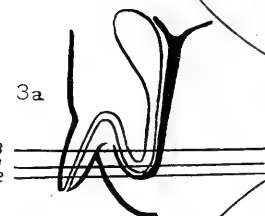
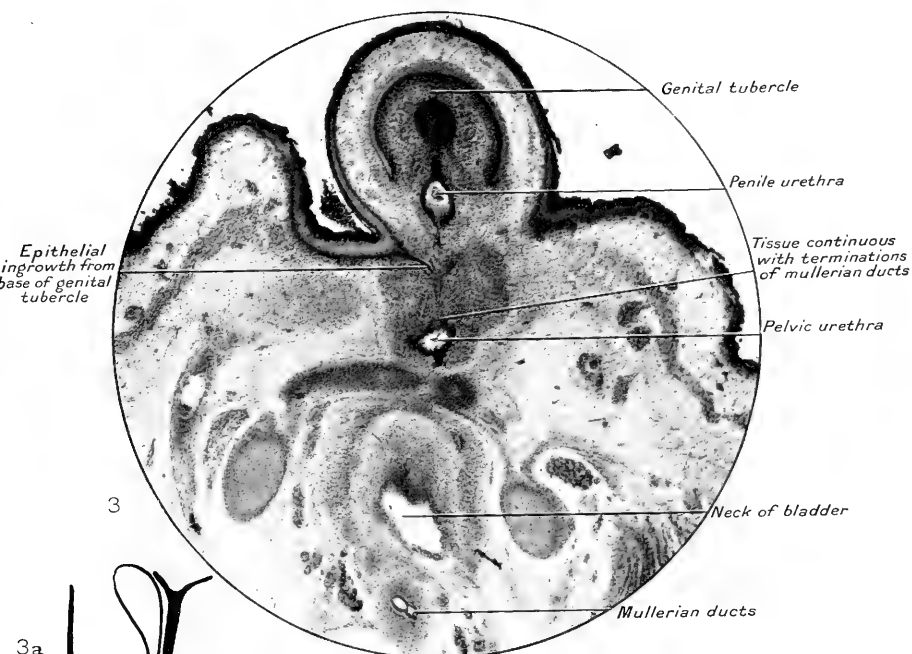
<i>Found in the following for the first time:</i>	HABITAT.
Yellow-fronted Barbet (<i>Cyanops flavifrons</i>)	Ceylon.
Mongolian Pheasant (<i>Phasianus mongolicus</i>)	Mongolia.
Goldfinch (<i>Carduelis elegans</i>)	N. Europe.
White-crested Touracou (<i>Turacus corythaix</i>)	S. Africa.
Swainson's Blue Jay (<i>Aphelocoma sordida</i>)	Mexico.
Wood-Thrush (<i>Turdus mustelinus</i>)	N. America.

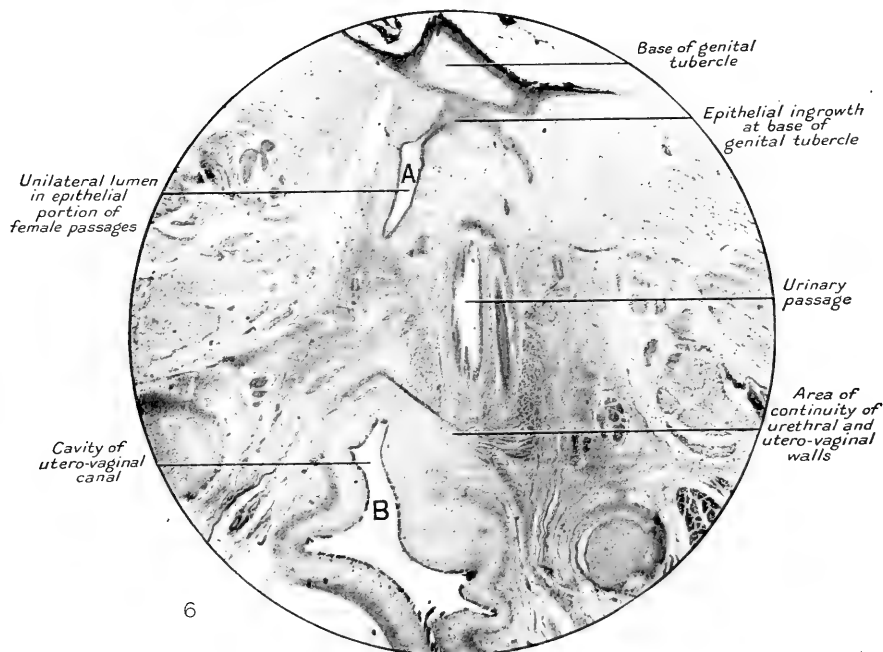
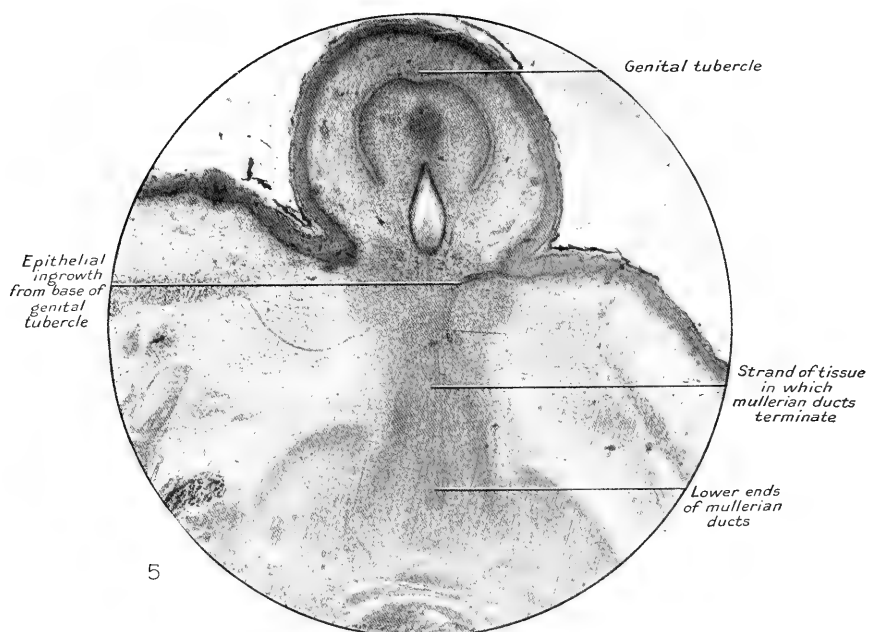
Leucocytozoa found in the blood of Birds.

2 Little Owls (<i>Athene noctua</i>)	S. Europe.
<i>Found in the following for the first time:</i>	
Chat (<i>Oreicola ferra</i>)	India.
Tawny Owl (<i>Syrnium aluco</i>)	Europe.



INTERNAL GENITALIA OF THE MOLE, ♀.





INTERNAL GENITALIA OF THE MOLE, ♀.

12. Some Phases in the Reproductive History of the Female Mole (*Talpa europea*). By FREDERIC WOOD-JONES, D.Sc., F.Z.S.

[Received February 3, 1914 : Read February 17, 1914.]

(Plates I.-III.,* and Text-figures 1-13.)

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A. Introduction.

For long it has been known to country folk that in some way the sexual life of the Mole (*Talpa europea*) is peculiar.

In an indefinite manner this idea has been given concrete form in works on Natural History, and practically every field-naturalist who has written of the habits of the mole has stated that the males greatly outnumber the females. Various habits of the mole are described which are supposed to be the outcome of this great preponderance of the males ; and most popular works allude to the love contests, the fierce battles, and the slaughter of the surplus males during the spring mating season. It is an observation which has been handed down almost unaltered from the very oldest authors, that the proportion of the sexes is equalised by the killing of superfluous males in the struggles of courtship.

I have, however, heard another account of this idea of the animal's sexual peculiarity from mole-catchers. I have been told by a most observant trapper that moles are all of one sex until their second season, and that then, and only then, do they become males and females. I do not know of any printed expression of this particular statement of a piece of nature lore, but I have no doubt the idea is more prevalent, among a class of men who gain a partial livelihood by mole trapping, than the mere repetition of an isolated observation might lead one to suppose.

The mole is an inconspicuous animal, not readily observed in its natural habitat nor easily kept in confinement, and so it has not reached the dignity attained by the spotted hyæna of having a literature of legend concerning its sexual habits which stretches back into the classics ; nevertheless it has taken its place among the creatures of fabulous habit in the nature lore of a very limited class of country folk.

As is the case with so many of the nature beliefs current up and down the country, there is far more than mere countryside superstition in this idea that the mole can change its sex, or at any rate its sexual appearances. As a matter of fact it is now more than eighty years ago that the question was removed from

* For explanation of the Plates see pp. 215-216.

the region of nature superstitions; but this has not yet effected a complete elimination from works on popular natural history of the imaginative accounts given by the older authors.

The apparent enormous preponderance of the males thrust itself upon the attention of Etienne Geoffroy (St. Hilaire), and to him is due the credit of placing on a firm scientific basis what was at the time a complete mystery to the scientific man and a subject of superstition to the ignorant (1). The work of Geoffroy was published in 1829, and, looking back, it seems a wonderful thing that this man, who with scalpel and forceps made clear all the essential facts, produced, in this respect, so little impression upon the succeeding generations of naturalists that all the old inaccuracies and traditions were repeated regularly in successive works on natural history.

In writings on the natural history of the Mammalia, for at any rate another seventy years, English authors were contented with a repetition of the popular stories concerning the numerical inequality of the sexes, and the supposed elimination of the superfluous males in the fierce contests of the pairing season.

Briefly, Geoffroy discovered by his investigations that although young moles all appeared to be males when the examination was confined to the external appearances of sex, yet, on dissection, some of these seeming males proved to be females in possession of well-developed internal female genitalia. Such a finding was indeed remarkable, but still the mole was by no means an isolated example of external sexual anomaly; for other cases of the difficulty, or even impossibility, of distinguishing the sex of mammals by mere external examination were already well known. But Geoffroy went further than this, for he showed that this peculiarity was limited to some females, and that although some appeared outwardly to be males, others, like the normal females of most mammals, possessed a vaginal orifice. In some females an organ almost exactly similar to the penis of the male alone existed, and in others there was an added orifice situated between the penis and the anus. This vaginal orifice he recognised as being a new formation in those females which possessed it; he assumed that this new orifice existed only after pairing, and he supposed it was actually produced by the efforts of the male in the act of copulation. It would be imagined that merely to call attention to this very unusual state of affairs would have been sufficient to attract a large army of anatomists and zoologists to the field of investigation, and yet but little attention seems to have been given to the subject. Indeed when, ten years later, Thomas Bell wrote his article on *Insectivora*, he opens his account of *Talpa* by saying "the female organs in the mole offer some peculiarities which deserve more attention than they have hitherto received" (2). Bell's account is obviously based upon the work of Geoffroy, and it is well to quote it in full. "In the first place, it appears that in this animal the urinary and genital orifices are wholly distinct. The clitoris, which is of

considerable length and very much resembles the penis of the male, is pierced for the passage of urine, and thus constitutes a true urinary penis. Beyond this is a transverse slit of a slightly crescentic form which constitutes the opening of the vagina. There are none of those duplicatures of the integument which in other mammalia constitute the *labia* and *nymphae*, but the skin is smooth. But one of the most curious points in the structure of these parts is that in the virgin state this vaginal aperture does not exist, the skin being perfectly and tightly drawn over the entrance; so that there are in this state but two openings, the urethral and the intestinal. So perfectly is this the case that it is very difficult to know a virgin female mole from the male by mere external examination. As this covering is so tense, the utility of the little bone at the extremity of the penis in the male is very obvious, and its pointed and tapering form is at once accounted for; for it is clearly intended to perforate this tense covering to the vagina."

After another thirty years the subject is again brought forward, in the form of references to Bell's article, by Owen in his 'Comparative Anatomy of the Vertebrates' (3). But Owen's plain statement that "the mole shows a complete closure of the vaginal orifice in the virgin state" tended rather to suggest that nothing more strange than an unusual development of the hymen accounted for the condition. The fact that no vaginal orifice existed was rather lost sight of in the suggestion that the outlet was merely closed in the virgin state. By 1868, therefore, this extraordinary discovery had found its place, but only as a brief allusion, and in a rather modified form, in the standard work on comparative anatomy; and it still rested apparently entirely upon the isolated investigations of Geoffroy carried out forty years before.

So far as I can ascertain the whole question was then practically lost sight of, or forgotten, until 1902, when Lionel E. Adams, after a wide experience of work as a field-naturalist, read a paper, entitled "A Contribution to our Knowledge of the Mole," before the Manchester Literary and Philosophical Society. To the older work of Geoffroy, Adams added original observations based on a very wide first-hand knowledge of the mole; and in addition to describing in detail the naked-eye external changes which accompany the formation of the vagina, it was made clear that this vaginal development was in a way spontaneous and not due to any action of the male.

The work of Adams was published in 1903 (4); it remains the standard account of the progress of this wonderful change, and as such is referred to in most recent works on zoology. Quoting from his original paper, the results are summarised as follows:—"My observations show that about March 1st a wrinkle appears at the base of the clitoris which in a few days assumes a purple hue, and by the middle of March a perforation appears in this livid wrinkle on each side of the middle line. Towards the end

of March these two perforations coalesce and the vagina is then open for penetration in the usual way. I have not found any internal hymen whatever."

Such a statement may be considered as a summing up of our knowledge of a process which one would suppose would arrest the attention of any anatomist, a process by which an animal evolves in its post-natal stages an entirely new orifice for the genital system, and changes an apparently male arrangement of external genitalia into one that is obviously female.

This brief history of the subject, incomplete in its details as it very possibly is, seems to me to be highly instructive, if only for the light it throws upon the relation of what we are apt to despise as mere nature lore to the more rigid demands of accurate anatomical knowledge.

It is now more than twenty years ago that a mole-catcher told me that all first-season moles were alike as to their external genital organs, and that only in their breeding year could they be distinguished as males and females. I do not imagine that the knowledge originated with this man, but would be inclined to regard him as merely a link in a very long chain of folk whose knowledge was certainly not gained from books, but was culled from real observation and backed by the weight of tradition. It was easy to regard a mole-catcher's statements as mere superstitions until the work of Professor J. P. Hill (5) on *Perameles*, and some study of the developing vagina in the human embryo, compelled a belief in the enormous plasticity and adaptability of the female genital tract, and lent colour to the suggestion that a vagina could be produced *de novo* in post-natal life. It was only then that preliminary investigations showed that the superstitions regarding this transformation of the mole were well founded; and a search of the literature revealed the work of Geoffroy and Adams.

B. *Embryonic Stages of External Genitalia.*

I shall begin my account of the development and transformations of the genitalia of the Mole by a brief description of the formation of the external genitalia in the embryo. I have been fortunate in the examination of a very large series of embryos of all ages, and for the bulk of this material I am indebted to Mr. R. H. Burne, of the Royal College of Surgeons, who has placed at my disposal a large number of foetal families collected with the greatest care, and in a perfect state of preservation. Other embryos I have collected for myself, or have received from time to time from friends, and the entire series has permitted the examination of the external genitalia in all phases of embryonic development.

I have been very careful in following, and attempting to interpret, these stages correctly, and the reason for this especial caution demands explanation. Hitherto my actual first-hand

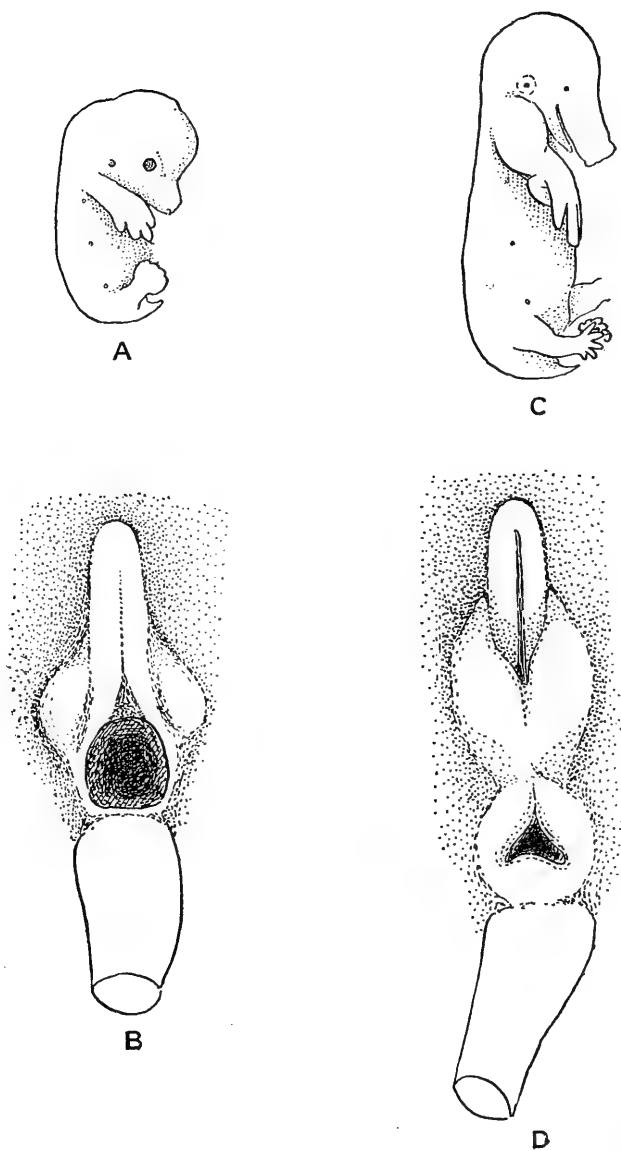
knowledge of the process of development of the external genitalia had been limited to the detailed study of human embryos. I had long since satisfied myself as to the method of development of the human external genitalia, and I had become convinced that some of the processes which are usually described did not in fact exist. The most cursory examination of my series of mole embryos, however, seemed to show that what I had regarded as, and stated to be (6), inaccuracies in the account of human development, were actual and obvious phases in the mole. Such a result necessitated a most careful review of my material, for it seemed that what was so obvious in the mole embryo was sufficient to stultify my assertions regarding human development. To assure myself of the correctness of my interpretation of the phases in the mole was therefore essential, and I have accordingly submitted all my material to a very critical examination. The results given here may therefore be taken as those which are so evidently true that, after repeated examination, they had to be accepted—though unwillingly—as correct.

The reinvestigation of the phases in human development was the next step, and the results of this part of the research I reserve for a further paper.

In the mole embryo measuring 9 mm. along the dorsal surface from the vertex to the caudal bend, the rudiments of all the essential elements of the external genitalia are readily recognisable. Such a stage is shown in text-fig. 1 (A & B). The cloaca is present as a wide orifice, from the ventral margin of which the genital tubercle projects. The urethral groove is present upon the cloacal aspect of the genital tubercle, and the margins of the groove (inner genital folds) are widely separated at the base of the tubercle and fade away posteriorly within the cloacal margins. The separate visceral orifices opening into the cloaca are not recognisable by external examination at this stage. Upon the lateral aspects of the base of the genital tubercle, continued in a caudal direction as the lips of the cloacal opening, are the labia majora (labio-scrotal folds). The labio-scrotal folds are lost in a cephalic direction upon the skin of the abdomen in front of the genital tubercle; they swell out as two ovoid prominences at its base, and diminish again towards the tail by skirting, as slightly elevated margins, around the cloacal orifice.

In the next stage, an embryo of 18 mm. shows that the genital tubercle has elongated, and the urethral groove become closed by the meeting of the labia minora along its cloacal aspect; but the outstanding feature of the changes consists of an extensive growth of the labio-scrotal folds (text-fig. 1, C & D). So extensive is this growth that the base of the genital tubercle has been buried beneath the ingrowing mesial margins of the two ovoid prominences present in this position in the 9 mm. stage. The urethral channel has been completed by closure of the inner genital folds, and now, over this closed urethra, the outer genital folds have met in the mid line. The dorsal portion of the cloaca is now

Text-figure 1.



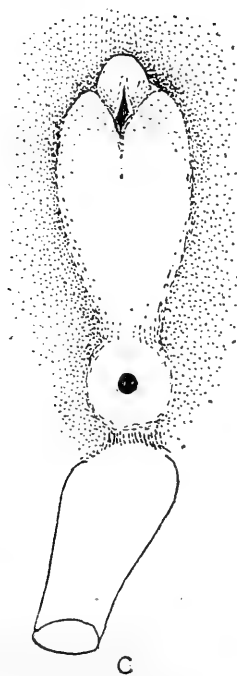
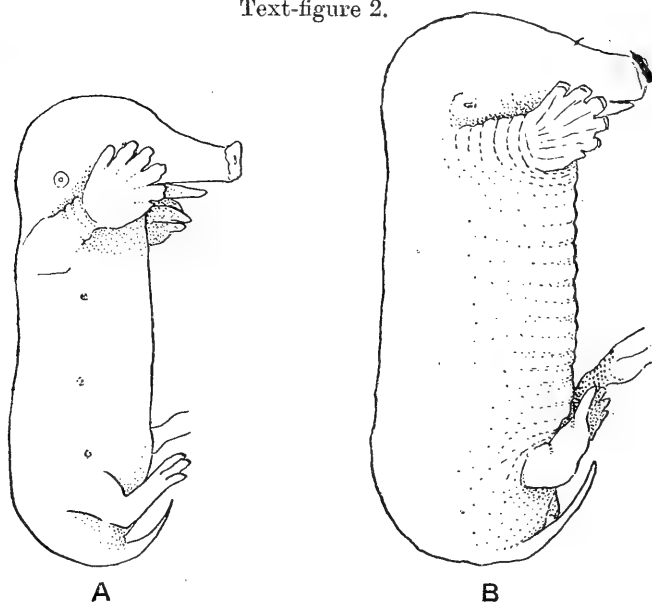
A. Embryo of 9 mm.

B. External genitalia : 9 mm. stage.

C. Embryo of 18 mm.

D. External genitalia : 18 mm. stage.

Text-figure 2.



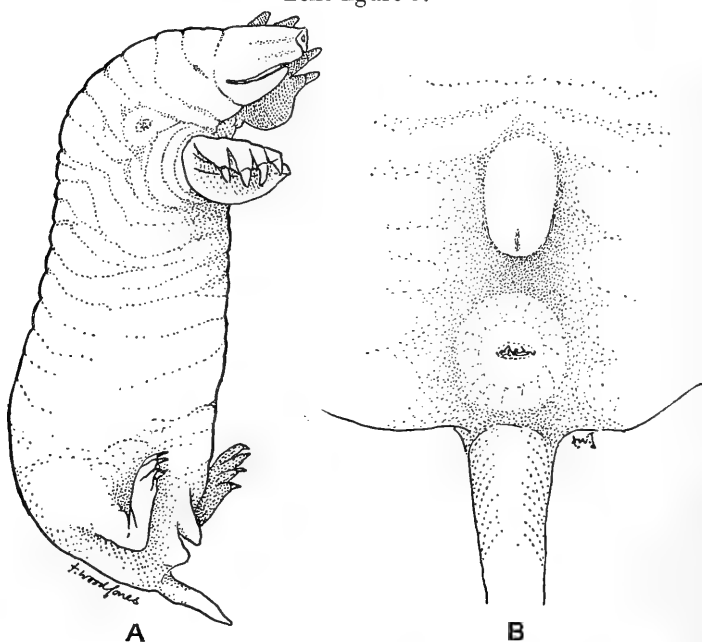
A. Embryo of 23 mm.
B. Embryo of 27 mm.

C. External genitalia: 27 mm. stage.

cut off from the base of the genital tubercle and the urethra by the meeting of the outer genital folds: and in this way the anus becomes a separate orifice.

The ingrowth and meeting of the outer genital folds take place first at the base of the genital tubercle at the site of their first prominence; and a constriction in their breadth in front of the anus marks this first union. At this stage the anus is triangular in outline, the apex of the triangle being directed towards the genital tubercle and corresponding with the primary ingrowth of the outer genital folds. In addition to this ingrowth, the outer genital folds have also become elongated, so that although the genital tubercle has increased greatly in length, it has become buried to a great extent beneath the overgrowing outer genital folds. Upon the portion of the genital tubercle which is still

Text-figure 3.



A. Hairless nestling: ♀, 59 mm.

B. External genitalia at this stage.

exposed beyond the fused outer genital folds, the median raphé, formed by the union of the inner genital folds, is plainly visible. This raphé does not extend to the free extremity of the exposed genital tubercle.

By the time the embryo is approaching full term and is 27 mm. long, the growth of the outer genital folds has become so preponderant that the genital tubercle is practically hidden beneath

their invading margin (text-fig. 2, B & C). The anus has become circular in outline and its margins have become more distinctly separated from the skin which forms the perineum, for although by no means so protuberant as in the adult, the anus of the more mature embryo is situated upon the apex of a conical tumid mound which rises from the general surface of the perineum. The genital tubercle ensheathed in the overgrown outer genital folds has become recognisable as the adult penis, and between this penis and the anus the prominence of the outer genital folds has diminished to make a more or less flattened area—the adult perineum. By full term (30–40 mm.) the genital tubercle is completely ensheathed, and hidden from view, within a prepuce derived from the outer genital folds; the anus is situated at the summit of a conical elevation of skin, and the perineum shows neither a median raphe nor an elevation due to the presence of the outer genital folds. The naked nestling shows the same condition with all the parts considerably enlarged (text-fig. 3).

The stages that have been described take place in exactly the same manner in both sexes; so it seems obvious, from external examination, that in the female, as well as in the male, the urogenital sinus must be carried forwards, by closure of the inner genital folds, to the tip of the genital tubercle, which then becomes secondarily ensheathed within the overgrowing outer genital folds. In other words, it appears as though the outlet for the genital products in both sexes must be at the extremity of the penis or clitoris.

C. Post-natal Stages of External Genitalia.

As Thomas Bell truly said, “it is very difficult to know a virgin female mole from the male.”

Moles breed but once a year, and an extended series of observations by Adams and others proves that in the great majority of cases the three or four young are born during the month of May.

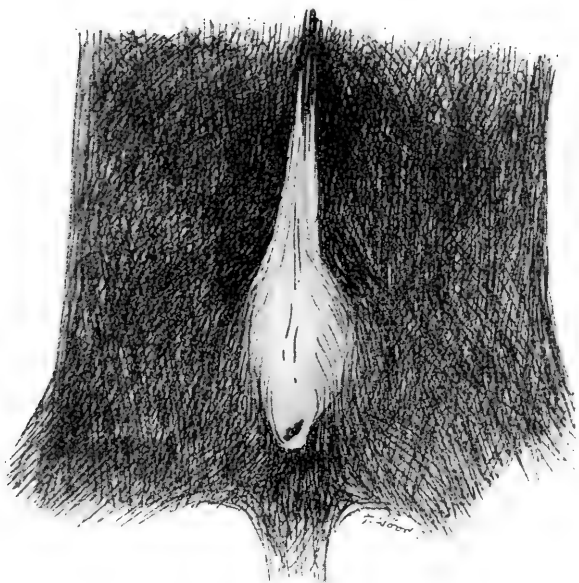
These young grow very rapidly. According to Adams (7) they double their length within the first ten days of their life; three weeks after birth they are three-quarters grown (H. E. Forrest, 8), and by the later months of the year they resemble the previous year's adults in all obvious characters.

I started collecting moles for examination in the autumn months; and from among the many individuals secured it was not difficult, after some experience, to pick out the females of the year.

Text-fig. 4 shows the condition of the external genitalia present in these young females. The particular specimen figured was caught in November, and it shows but little modification of the late fetal and early nestling conditions already described. Text-fig. 5 shows the condition of a male taken at the same time, and

in a general way its external genitalia may be said to be similar to those of the female. Still, though it is admittedly a matter of difficulty to be absolutely certain of the sex of an individual, there are minor characters, which in typical cases furnish some indications upon which to make a correct diagnosis fairly certain.

Text-figure 4.



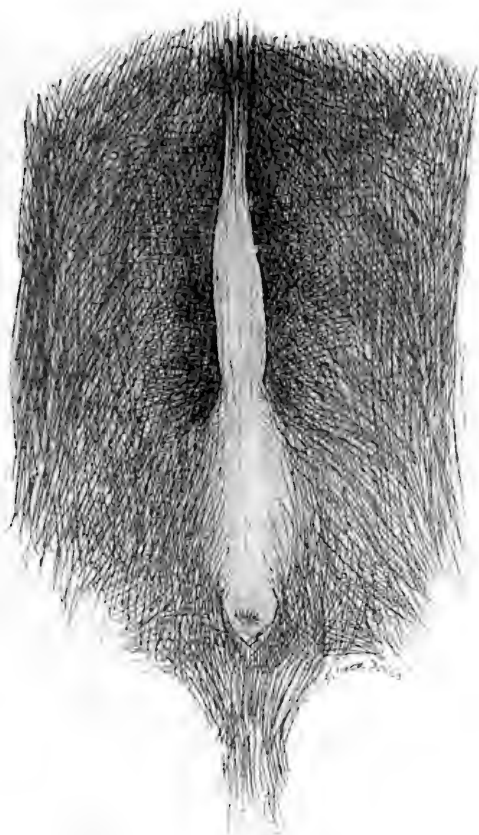
External genitalia of a young female in the autumn of the first year.

In the first place the clitoris of the female, though remarkably like the penis of the male, is, as a rule, slightly smaller, and in most cases, its root slopes more gently to the perineum, so that its base merges with the perineal skin with less line of demarcation than is present in the male. Another fairly obvious distinction is the shorter distance between the root of the clitoris and the anus in the female. In some cases, but I think not in all, this sexual difference is noticeable; it was remarked on by Geoffroy, and, taken with the condition of the genital organ, it gives the best guide for determining the sex of young individuals.

It will be noticed that in the virgin female in the late autumn months, just as in the mature embryo, the perineum presents a smooth unbroken surface. There is no wrinkle or pucker; no depression or blind pit, to mark a closed female genital orifice. It is not the case, as the description of Owen might lead one to

suppose, that a vagina closed by a thickened hymen is present; for in the female as in the male, the perineal skin passes without interruption from the base of the genital tubercle to the margin of the anus. Such a description holds good, I think, for all first year females during the autumn and winter months; but in the early spring external changes are apparent. In the second week

Text-figure 5.

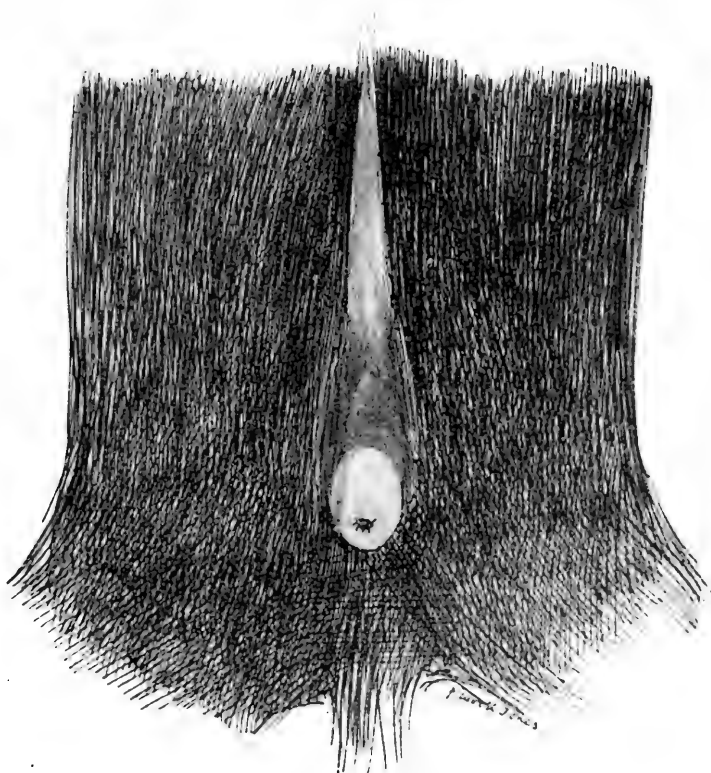


External genitalia of a normal male.

of March in moles caught in Epsom, and during the third week in moles caught in the neighbourhood of East Grinstead, the perineum had become pigmented. This pigmentation, so far as my observations go, occurs at first in the absence of any anatomical change in the perineum.

The genital tubercle becomes more vascular, and, in the recently dead specimen, is intensely injected and vivid red; the anus shares to a lesser degree in this change, and although the vivid redness may be in part a mere post-mortem phenomenon there can be no doubt as to the increased vascularity of the parts. This phase of pigmentation is shown in text-fig. 6. In well-marked

Text-figure 6.



External genitalia of a young female taken in March.
Stage at which pigmentation is present.

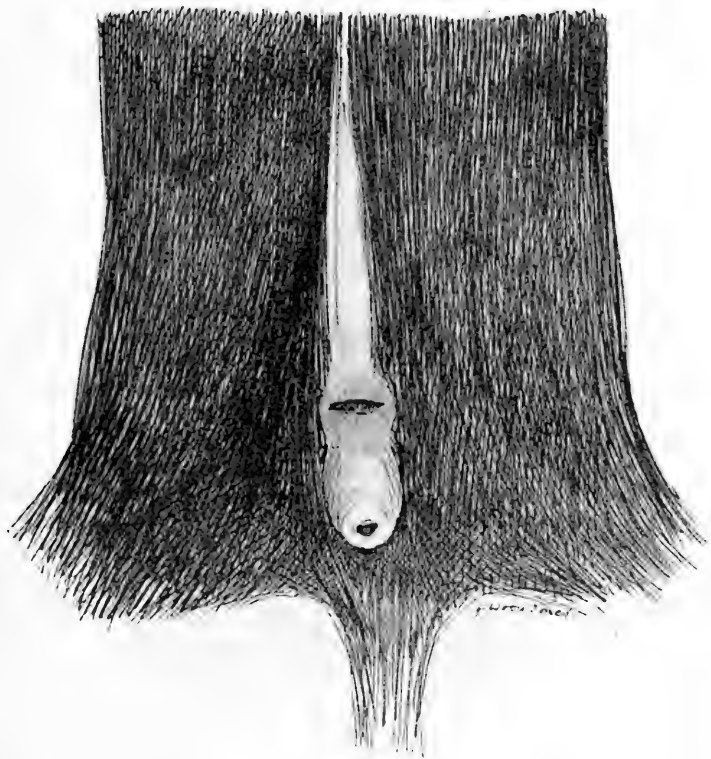
contrast to this redness of the genital tubercle, the perineum shows a bluish coloration which is reminiscent of the sexual perineal pigmentation displayed in some Primates. This blue pigmentation is certainly not a post-mortem change, and indeed there are some indications that it tends to fade after death.

Later in March this pigmentation becomes more vivid; the whole perineal structures are enlarged and highly vascular, and

the blueness of the base of the genital tubercle is increasingly conspicuous.

The next stage that I have had the opportunity of examining in a perfectly fresh condition is that seen in specimens taken in the first week of April, and in these a vaginal orifice is evidently recently established in the midst of the blue area. This orifice is placed with its long axis transversely in the perineum, and it

Text-figure 7.



External genitalia of a young female taken in April.

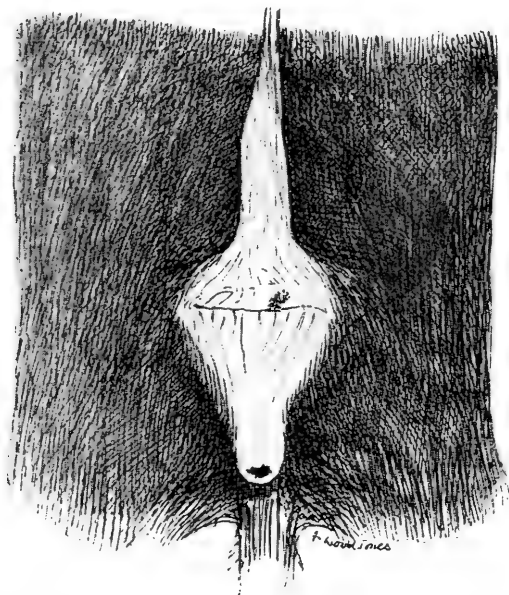
Stage at which perforation is present.

is a mere break in the continuity of the perineal tissues; its margins show no signs of any genital folds such as are commonly present in some form or other, nor has it even the regular outline of the ordinary non-genital visceral orifices. This opening is situated near to the base of the genital tubercle, but I fancy that even its exact site is subject to some slight variations within the narrow limits of the perineum, and its distance

from the genital tubercle does not seem to be absolutely constant (text-fig. 7).

Towards the end of April the colour fades from the perineum, but the female genital orifice remains widely patent, and during the month of May parturition usually takes place. I have not actually seen the bilateral perforations described by Adams, for all the specimens I was able to procure at about the critical period had either an entirely imperforate blue area, or else had a vaginal cleft established. It has seemed to me in several instances that the purple pigmentation was most marked immediately upon either side of the middle line, and though I have not myself yet come upon a stage in which the perforation was bilateral, I have every reason to suppose such a condition to be extremely probable.

Text-figure 8.



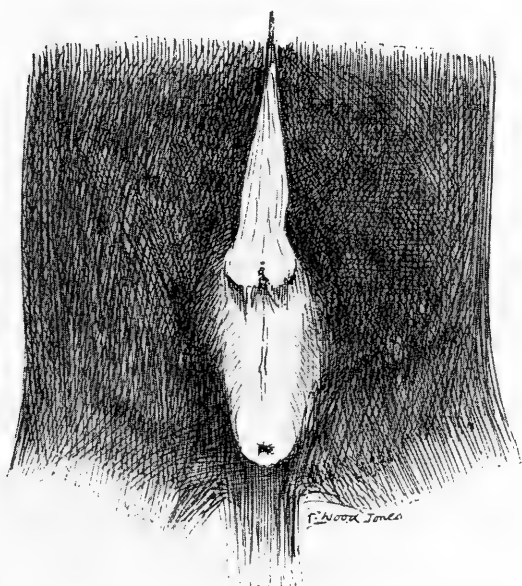
Winter female with pigmented perineal scar (Nov. 20th). Second year.

After parturition is effected retrogressive changes evidently take place, and in the later months of the year some most interesting phases are met with. This vaginal orifice, which is formed in such a curious way, tends again to become occluded in the autumn months, and in by far the greater number of specimens that I have examined, the outlet for the female

genital ducts becomes entirely closed again within a very short space of time.

Some specimens examined in the autumn months show nothing more than a wrinkled surface at the base of the genital tubercle, and somewhere in this wrinkled area is commonly a patch, or a series of minute patches of dark pigment (text-fig. 8). Others show a very definite transverse scar, more or less puckered, and generally pigmented in some portion of its length (text-fig. 9). At times this scar formation is irregular, and pockets will penetrate some distance into the perineal tissues. In one instance, a probe could be passed far into the vaginal mouth of a November mole, although this vagina did not form an open channel communicating with the uterus (text-fig. 10).

Text-figure 9.

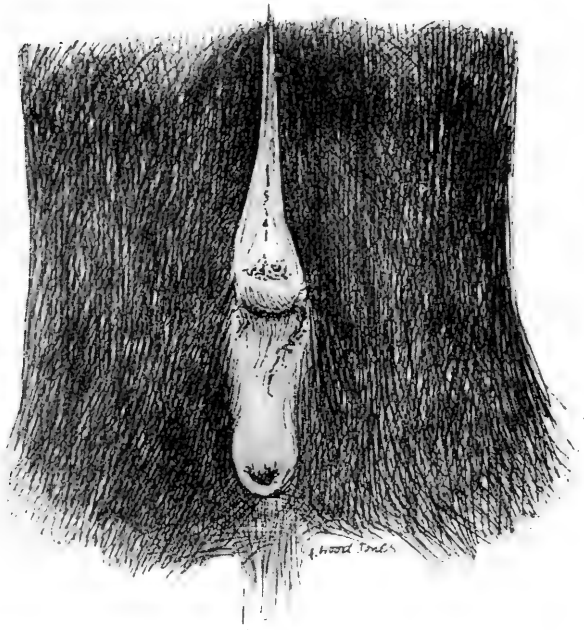


Winter female with perineal scar (Dec. 5th). Second year.

It would therefore seem that in virgin moles a vagina is formed in the early months of the spring; that after parturition has taken place it closes again in whole, or in part, and that by the autumn its orifice is represented by a mere perineal scar. I do not know how long moles live, nor how many times they breed, but it would seem that at every recurrent breeding season the process was repeated, and the vaginal orifice re-established. So far as I have been able to determine, the vagina as a patent

canal communicating with the uterus does not usually become established as a permanency in the mole, but the experience of meeting with one winter female with a patent vagina would make me prepared to believe that at times the communication may be permanently established. We have in this process a most remarkable parallel to the evolution of the medina vagina of the Marsupials, to which reference will be made later.

Text-figure 10.



Winter female with a perineal orifice (Dec. 5th). Second year.

D. *Embryonic Stages of Internal Genitalia.*

In order to follow the embryonic development of the female genital ducts and orifices, I have been compelled to prepare a very large series of sections, for the difficulty of distinguishing the sexes during embryonic life renders the selection of material exceedingly difficult. The female ducts have been followed in their entire length in embryos of 27 mm. and 33 mm. respectively.

In the earlier of these stages the arrangement of the ducts is comparatively simple, for in the female, just as in the male, the genital ducts end separately in the floor of the closed uro-genital

sinus. As the urinary passage passes from the bladder towards the urethral outlet at the tip of the genital tubercle it describes a curve of which the convexity is directed caudad: it is at the lowest part of this bend that the female genital ducts terminate in the urethra. The Mullerian ducts pass down dorsal to the bladder and urethra, and then running ventrally with a curve similar to that of the urethra, they terminate at the caudal floor of the urethral bend.

This termination is made in the immediate neighbourhood of the orifice of the Wolffian ducts, and a considerable proliferation of epithelium marks the actual site of the ends of the ducts of Muller (Pl. I. figs. 1 & 2).

In the embryo of 27 mm. the continuity of the Mullerian ducts and the urethral passage is easy to trace, although the proliferation of the Mullerian epithelium makes the continuity of the lumina difficult to establish with certainty.

So far this must be considered merely as a primitive arrangement in which separate Mullerian ducts terminate in a uro-genital sinus in the neighbourhood of the Wolffian ducts; and the peculiarity which exists in *Talpa* at this stage is that the uro-genital sinus is closed in, and carried forwards to the tip of the genital tubercle, in the female as it is in the male. Were it not for this penile prolongation of the female uro-genital sinus, there would be nothing very remarkable in the primitive condition of *Talpa* at this stage.

Even in this peculiarity *Talpa* is not unique; for very similar conditions are known to be present in some other animals.

Among Insectivores several species have been described as having the genital tubercle tunnelled by the urethra in the female; this condition occurs again among the Lemurs, and, according to Chapman, *Capromys pilorides* among the Rodents shows a like conformation of the clitoris in the female. In all these types, however, the Mullerian ducts open in the normal way by a separate vagina, and no great physiological questions are raised by this anatomical arrangement. But the condition described by Morrison Watson (9) and by Chapman (10) in *Hyæna crocuta* appears to be an exact parallel to the virgin condition of *Talpa*. Assuming that it is not by the mere coincidence that only virgin examples of *Hyæna crocuta* have ever been examined by anatomists, we must suppose that the condition in this case is permanent; that no new vagina is ever formed; that copulation takes place *via* the urethra, and that the young are born by the same route—through the tip of the clitoris.

In *Talpa* it is evident that this primitive condition does not last long, for already in the embryo of 33 mm. the Mullerian epithelial proliferation has proceeded a stage further and the lower ends of the Mullerian ducts are somewhat more separated from the wall of the urinary passage. The condition seen at this stage is as follows. The Mullerian ducts which above are united

into a common chamber having a wide lumen, separate again as they approach the pelvis, and the lumen of each individual duct becomes occluded by the proliferating epithelium of its walls (Pl. II. fig. 2). In this occluded state they pass as epithelial cords dorsad to the urinary canal and, sweeping into the pelvis caudad to it, may be traced past the openings of the minute Wolffian ducts.

From this point onward each Mullerian cord may be traced as a delicate epithelial strand caudad and ventrad of the urethra, still in intimate relation with the wall of the urethra, but apparently altogether separated from its lumen.

This is the state of affairs at the caudad bend of the urethra. From here the urethra and the crura clitoridis turn cephalad again to the genital tubercle, the tissues of which they penetrate; but the Mullerian strands do not take part in this cephalad bend, for they continue their course towards the base of the genital tubercle rather than towards the central mass of its tissues. It is here that the most curious feature in the development of the female genital system of *Talpa* is seen. The genital tubercle itself is, of course, covered by the general many-layered cutaneous epithelium which here shows but few hair rudiments. At the lateral and inferior margins of the genital tubercle just where it joins the general skin of the perineal region, the deeper layer of the perineal skin dips inwards into the perineal tissues as two lateral cords which become continuous below the sides of the urethra with the similarly solid Mullerian cord.

I have spoken of these solid cords as being bilateral, but in the embryo of 33 mm., of which I have serial pelvic sections, I have been able to trace the continuity of the surface epithelium with the Mullerian cord only upon the left side, although in the same situation upon the right side is a well-marked stream-line of the cells of the perineal tissues (Pl. III. fig. 1, the figure is reversed). This unilateral condition of the epithelial ingrowth is worthy of notice, for again at a later stage I have observed the same thing: and it becomes significant when taken in conjunction with the observation of Adams that the adult vagina is perforated by bilateral breaking down of the perineal tissues. The changes that have taken place in the interval between the 27 mm. stage and the 33 mm. stage are not really very great, for the rudiments of all the conditions described in the 33 mm. embryo are already present in that of the 27 mm. embryo. Although in the younger example the Mullerian ducts definitely join the urethral wall at their lower ends, still, even at this stage, an epithelial prolongation from them may be followed around the caudal bend of the urethra towards the base of the genital tubercle, and, moreover, an epithelial ingrowth from the skin of the base of the genital tubercle is already in process of development. In this younger embryo the ingrowth is again unilateral, being found in my series only upon the right side (Pl. II. fig. 1: the figure is reversed).

The embryonic condition of the female passages is therefore a

curious one—though it must be remembered that it has its parallel in general mammalian, and even in human development. The Mullerian ducts open first into a cloacal uro-genital sinus; at a later stage this opening is lost and the lumen of the ducts becomes obliterated. The Mullerian ducts become mere Mullerian cell-strands, and these cell-strands pass forwards below the urethral floor, and mesial to the crura clitoridis, towards the base of the genital tubercle. It is at the base of the genital tubercle that the uro-genital sinus approaches nearest to the surface of the body, and here a proliferation of surface epithelium dips in towards it.

This epithelial invasion is crescent-shaped in outline (corresponding with the base of the genital tubercle), and the extremities of the crescent dip into the perineal tissues and meet the Mullerian epithelial strand. In the embryos examined the right horn of the crescent in one case, and the left in the other, alone extends inwards to the termination of the Mullerian strand.

E. *Postnatal Stages of Internal Genitalia.*

(i.) *The Nestling Mole.*

The young mole is born in a naked and rather immature condition, and although the growth within the first few days of life is extraordinarily rapid, it is not until about the 9th day that the colour changes from the primitive pink to the dull lead-colour that marks the advent of hair. At about the end of the first fortnight the actual hair appears.

This period of life has been fully observed from the field-naturalist's point of view by Adams, Cocks, and Evans (all quoted by Barrett-Hamilton, 7).

It was obvious from the outset of my investigation that the nestling period was one of the utmost importance, for it was evident that it was not only a time of extremely active body growth, but that remarkably rapid internal changes must be taking place as well. Indeed there may be said to be two well-marked phases of wonderfully rapid evolution in the reproductive system of the mole, the one being present during this nestling period, and the other being marked by those almost violent changes which occur during the short but intense period of sexual activity.

I have found specimens of nestling moles particularly difficult to obtain, and during two breeding seasons I have failed to find nestlings, although I have had adults in all phases of sexual activity. For the only material which I have been enabled to examine microscopically in serial sections, I am indebted to Professor L. Doncaster. This material, which consisted of two specimens, is of interest, for the nestlings were presented to the Cambridge University Museum of Zoology by the Rev. Leonard Jenyns, and had been in their bottle of spirit for at least some

seventy or eighty years when the sections were cut, and yet the histological condition of the tissues remains extremely good. The nestlings are immature and pink, and are devoid of obvious hair except along the margins of the tail. The eye has become further reduced from the late foetal condition; the ear appears in extraordinary proximity to the shoulder, and the genitalia are in practically their adult condition. The vertex-rump measurement of one (♀) is 59 mm. (text-fig. 3, A) and of the other (♂) 62 mm.

The serial sections of the female specimen show that a great advance has been made on the condition seen in the full-term embryo, the development of the genital system taking place between the 33 mm. and 59 mm. stages being remarkable.

In the first place the utero-vaginal canal has lost all trace of its bilateral origin, for the Mullerian tract is now a wide canal with well differentiated walls. The whole picture of the pelvic relations has altered by this rapid growth of the female genital passages, for whereas in the embryonic stages the urinary tract was far wider than the genital passage, in the nestling the utero-vaginal canal is the most conspicuous viscus in this region (Pl. III. fig. 2).

Another well-marked change is the complete separation of the cavities and the almost complete separation of the walls of these two passages, for it is only over a very small area that the musculature of the genital and urinary tracts becomes united. But although the separation of the two channels has thus become more marked, there is as yet but little advance on the embryonic condition towards the establishment of a new orifice for the female ducts. The epithelial ingrowth at the base of the genital tubercle has become more conspicuous, and with the increased growth of the parts it is still further separated from the centrally-lying urethra.

Advanced as is the development of the female passages at this stage, there is, however, still a very imperfect union of the epithelial ingrowth and the utero-vaginal canal.

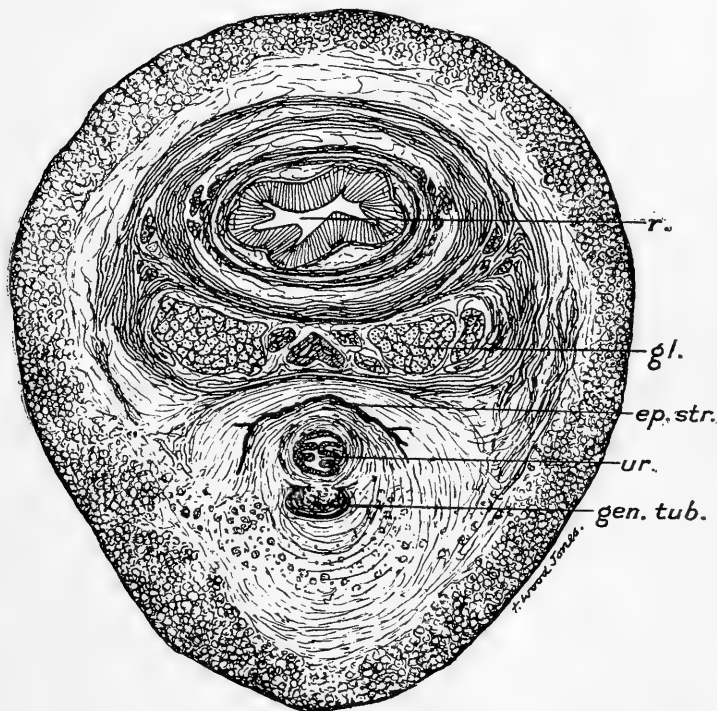
In the specimen examined in serial sections it is only upon the right side that the ingrowth meets the patent utero-vaginal canal; so that it is only on the right of the urinary passage that there is even an epithelial continuity between the female genital system and the surface of the body. The left side of the epithelial crescent is well developed, but it remains widely separated from the utero-vaginal lumen (Pl. III. fig. 2: the figure is reversed).

(ii.) *The Adult.*

There is no need to describe the uterus and its adnexa in the adult, for this description has been furnished many times by comparative anatomists who have examined second year females. It was evidently only the female of the second year that was examined by John Hunter, for he says (11):—"There is no common vagina; the vagina is very long and runs in a serpentine

course forwards and backwards." By "common vagina" Hunter doubtless means urogenital sinus, and the serpentine condition of the vagina may be taken as an indication that the mole dissected was not a virgin female in its first year. It is remarkable that no chance ever brought to John Hunter an example of a female mole in its virgin condition. Our knowledge is the poorer as a consequence; for the reflections of the man who observed that "there is very little fat on a mole" upon discovering the absence of an outlet for the female genital tract can well be imagined.

Text-figure 11.



Section through the pelvis of a female of the first year (November).

The female genital passages are represented by the solid epithelial strand (*ep.str.*).

r., rectum; *gl.*, gland; *ur.*, urethra; *gen. tub.*, genital tubercle.

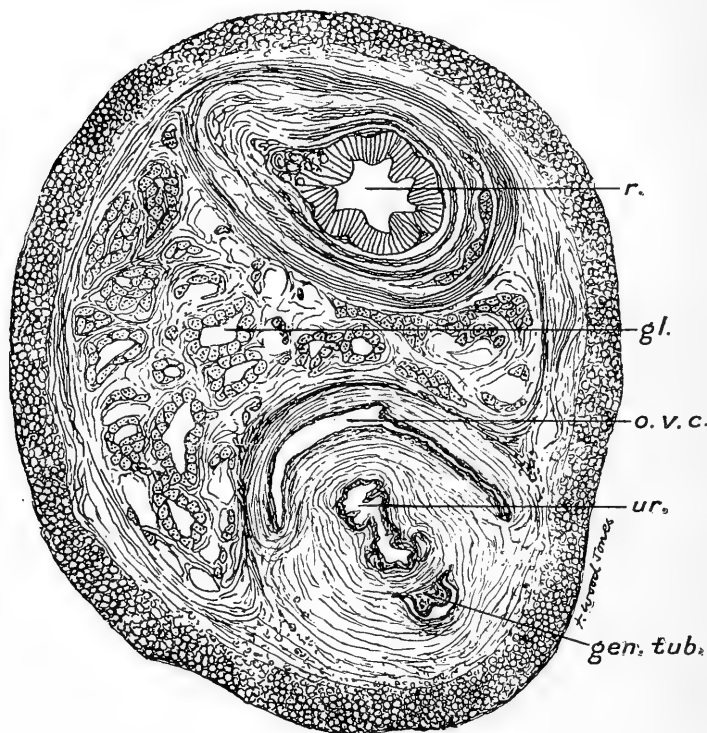
The descriptions of Owen and others are obviously founded upon the examination of similar material.

In describing the genitalia of any mammal—and this applies more especially to the Insectivora—it is almost essential to record the condition of sexual activity in which the organs were at the

time of examination. In most of the Insectivora there is an almost complete anatomical transformation during the brief flare up of sexual activity at the pairing season.

During a very few weeks, parts which were altogether insignificant have become increased ten times, or more, in size; and this is even more obvious in the male than in the female.

Text-figure 12.



Section through the pelvis of a female of the second year (April).

The epithelial strand has now broken down into the wide open vaginal canal (*o.v.c.*).

r., rectum; *gl.*, land; *ur.*, urethra; *gen. tub.*, genital tubercle.

The wonderful transformations which take place in the male genital glands have been described in detail by histologists. The whole of the female genital tract also undergoes these changes during the months of March and April, and an enormously increased blood supply is furnished to the genitalia during these months.

Examined during the autumn months of its first year, the

female shows but little advance upon the condition described as existing in the nestling of 59 mm. The utero-vaginal canal is a wide cavity which narrows below the neck of the bladder and passes, still as an open tube, towards the perineum at the base of the genital tubercle. But at a point some distance from the perineal surface it becomes closed by the approximation of its anterior and posterior walls, and is continued as a wide area of epithelial cells which becomes continuous with the skin at the base of the genital tubercle (text-fig. 11, p. 211).

There is, therefore, no outlet for the female genital passages, for the whole of the lower part of the tract is a solid epithelial mass, just as it is in the 59 mm. nestling.

The greatest advance to be noted in the adult examples of which I have prepared serial sections, is that the solid epithelial area is of greater lateral extent and becomes continuous with the whole of the lower, patent, extremity of the utero-vaginal canal.

In the pigmented young females taken in April a very great change is seen.

All parts of the genital tract are much enlarged, their tissues are all more vascular, and the large pre-anal gland mass has increased greatly in size. But the most important change consists in the complete opening of the lower part of the utero-vaginal canal by the desquamation of the central cells of the previously solid epithelial mass (text-figs. 12, 13, A). So far as can be determined from the material at my disposal, it would appear that with the increased vascularity of the parts in the months of March and April, a proliferation of the epithelial mass is initiated, that the central cells of the mass degenerate and are shed, and the peripheral cells become the lining epithelium of the cavity thus opened up (text-fig. 13, B).

In sections of the genital tract of non-virgin females caught in the autumn months the retrogressive changes are seen. The lower portion of the utero-vaginal canal is again occluded, but the occlusion is not uniform throughout the epithelial portion. Pockets run in from the surface, and in some cases these are deep enough to admit the tip of a probe, but beyond these pockets the occlusion is again complete in whole or in part.

F. *Summary and Conclusions.*

(a) Although the peculiarities of the female reproductive system of *Talpa europea* appear at first sight to be extremely anomalous, nevertheless they have, for the most part, some foreshadowings in the normal processes of development of other mammalian types.

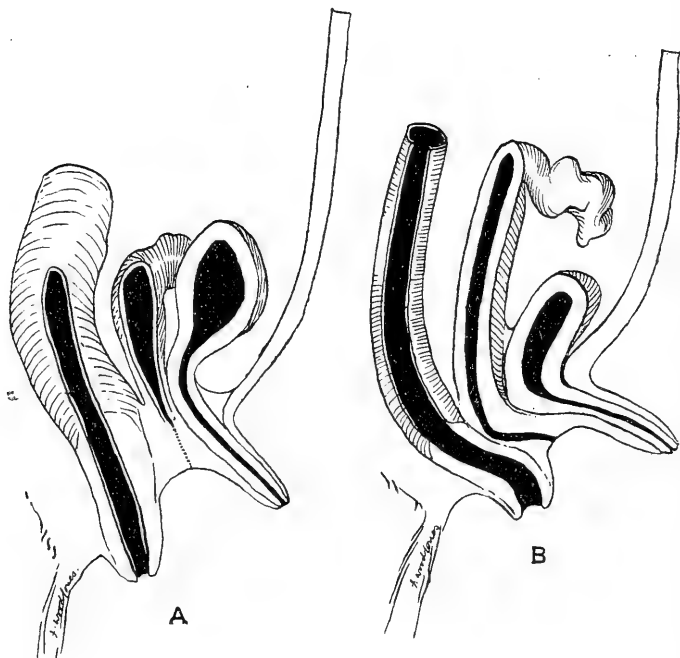
(b) Everything that is unusual concerning the female reproductive system is initiated in the early stages of embryonic development when, between the 9 mm. and 18 mm. stages, the labio-scrotal folds begin to grow towards the middle line over the closed urethra in the base of the genital tubercle.

(c) Without passing beyond the scope of the present paper it may be said that, in the method of development of the external genitalia, the male falls into line with some other members of the Insectivora, the Rodentia, Ungulata, and some other Orders.

(d) It is the female alone that is anomalous in following from the first a male type of formation of the external genitalia.

(e) Even this state of affairs would seem to be found again in the female of *Hyena crocuta*.

Text-figure 13.



A. Median section of pelvic viscera of a female of the first year (November).

The utero-vaginal canal ceases to be an open passage some distance from the surface, and is continued to the surface only by an epithelial strand.

B. Similar section of a female of the second year (April).

The utero-vaginal canal is open to the exterior at the base of the genital tubercle.

(f) There is nothing really remarkable in the shifting of the site of opening of the Mullerian ducts, nor is it unparalleled for them to end in solid epithelial prolongations.

(g) Both these phases are found in the normal development of

other animals, and both are stages in the normal formation of the female genital system of *Homo* (12). The imperforate vagina is a normal stage in the female human embryo, and this solid vagina becomes patent in very much the same way as does that of the mole—by desquamation of its central cells.

(h) The mole is exceptional in that the opening up of the solid vagina is so long delayed.

(i) Again, it is not without parallel that a vagina once formed should become occluded again, only to be reopened when next functional activity demands a passage; these phases have been established by Hill (5) with regard to the median vagina of *Perameles*.

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EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. Section of the pelvis of the 27 mm. embryo showing the lower ends of the Mullerian ducts.
2. Section of pelvis of 27 mm. embryo, slightly lower than fig. 1, showing the extreme limit of the caudal bend of the urethra, and the tissue in which the Mullerian ducts end.

PLATE II.

Fig. 3. Section of pelvis of 27 mm. embryo at a higher level than figs. 1 & 2 (Pl. I.). Section passes through the base of the genital tubercle and cuts through the urethra in three places.

3 a. Key to show the planes of sections illustrated in figs. 1-3.

4. Section of pelvis of 33 mm. embryo showing the double Mullerian ducts.

PLATE III.

Fig. 5. Section of pelvis of 33 mm. embryo at a slightly lower level than fig. 4 (Pl. II.). The section passes below the caudal bend of the urethra and shows the lower ends of the Mullerian ducts, the strand of tissue in which they terminate, and the epithelial ingrowths from the base of the genital tubercle.

6. Section of pelvis of 59 mm. nestling, just shaving the base of the genital tubercle. In more caudal sections the lumen A becomes continuous with the lumen B.

EXHIBITIONS AND NOTICES.

February 3, 1914.

SIR JOHN ROSE BRADFORD, K.C.M.G., D.Sc., F.R.S.,
Vice-President, in the Chair.

The SECRETARY read the following report on the additions to the Society's Menagerie during the months of November and December, 1913:—

NOVEMBER.

The number of registered additions to the Society's Menagerie during the month of November was 350. Of these 251 were acquired by presentation, 51 by purchase, 19 were received on deposit, 21 in exchange, and 8 were born in the Gardens.

The number of departures during the same period, by death and removals, was 237.

Amongst the additions special attention may be directed to:—

1 White-tailed Guereza (*Colobus caudatus*), from East Africa, new to the Collection, presented by G. St. J. Orde Browne, Esq., on November 3rd.

1 Cheetah (*Cynelurus jubatus*), from East Africa, presented by H.G. The Duke of Sutherland, F.Z.S., on November 7th.

1 Argentine Blackbird (*Merula fuscata*), new to the Collection, presented by R. Suggitt, Esq., on November 12th.

10 White-headed Starlings (*Poliopsar leucocephalus*), from Cochin China, new to the Collection, presented by W. O. Danckwerts, Esq., K.C., F.Z.S., on November 26th.

2 Red-billed Hornbills (*Lophoceros erythrorhynchus*), from Africa, received in exchange on November 11th.

1 Crowned Pigeon (*Goura coronata*), bred in the Menagerie on November 29th.

1 Hybrid between a Black-winged Peacock (*Pavo nigripennis*) and a Domestic Hen (*Gallus domesticus*), presented by R. P. Wheadon, Esq., on November 7th.

2 Kagus (*Rhinocetus jubatus*), from New Caledonia, presented by the Marquess of Tavistock, F.Z.S., on November 1st.

2 Masai Ostriches (*Struthio massaicus*), from East Africa, purchased on November 3rd.

A large Collection of Small Birds and Waterfowl, presented by Heatley Noble, Esq., F.Z.S., on November 24th.

DECEMBER.

The number of registered additions to the Society's Menagerie during the month of December was 166. Of these 89 were acquired by presentation, 31 by purchase, 19 were received on deposit, 26 in exchange, and 1 was born in the Gardens.

The number of departures during the same period, by death and removals, was 277.

Among the additions special attention may be directed to:—

1 Pigmy Hippopotamus (*Choeropsis liberiensis*) ♂, from Liberia, presented by H.G. The Duke of Bedford, K.G., Pres.Z.S., on December 16th.

2 Vicunas (*Lama vicugna*) ♂ ♀, from the Andes, presented by F. Lesser, Esq., on December 20th.

1 Cheetah (*Cynælurus jubatus*) ♀, from British East Africa, presented by Mrs. McMillan, F.Z.S., on December 20th.

1 Pine-Marten (*Mustela martes*), from Kerry, presented by H. G. Constable, Esq., F.Z.S., on December 11th.

3 Four-banded Chipping-Squirrels (*Eutamias quadrivittatus*), new to the Collection, deposited on December 1st.

1 Olive-backed Thrush (*Hylocichla ustulata swainsoni*), from North America, new to the Collection, received in exchange on December 23rd.

A large Collection of Birds, including a pair of Red-collared Lorikeets (*Trichoglossus rubritorques*), a number of Waterfowl and Small Birds, presented by Heatley Noble, Esq., F.Z.S., on December 1st.

4 South-African Ostriches (*Struthio australis*), bred in South Australia, deposited on December 12th.

29 Ornamented Ceratophrys (*Ceratophrys ornata*), from the Argentine, presented by E. G. Robinson, Esq., on December 23rd.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a photograph of two hybrids between a Peacock and a hen Guinea-fowl which were bred in Germany and were now in the Berlin Zoological Gardens, and remarked that there were three or four cases on record of such hybrids being produced, whereas there were only two instances known of the Peafowl crossing with the domestic fowl, and none, so far as he knew, with birds of any other genus.

Mr. Seth-Smith also showed the skin of a hybrid Pheasant hen, which had been sent to him by Mr. H. J. Elwes, F.R.S. This bird was one of a number bred in Sussex by Mrs. Johnstone, between a cock *Calophasis mikado* and hen *C. ellioti*. It bore a very strong resemblance to the female *C. mikado*, but showed a trace of the black throat and rufous barring to the tail of *C. ellioti*.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., gave an account of the collections of Batrachians and Reptiles made by the British Ornithologists' Union and the Wollaston Expeditions in Dutch New Guinea. Four species of Batrachians and eight species of Reptiles were described as new.

This paper will be published in the 'Transactions.'

February 17, 1914.

Prof. E. A. MINCHIN, M.A., F.R.S., F.Z.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the additions to the Society's Menagerie during the month of January 1914:—

The number of registered additions to the Society's Menagerie during the month of January was 151. Of these 73 were acquired by presentation, 23 by purchase, 23 were received on deposit, and 32 in exchange.

The number of departures during the same period, by death and removals, was 209.

Amongst the additions special attention may be directed to:—

A pair of Park Cattle (*Bos taurus*), from Chillingham, presented by the Earl of Tankerville, F.Z.S., on January 28th.

A pair of Indian Wild Dogs (*Cyon dukhunensis*), from Nagpur, presented by Mrs. H. A. Crump on January 23rd.

1 Brown-shouldered Hangnest (*Icterus pyrrhopterus*), from Brazil, new to the Collection, presented by T. W. Smith, Esq., on January 20th.

2 Cuban Conures (*Conurus euops*), new to the Collection, presented by the Marquess of Tavistock, F.Z.S., on January 23rd.

1 Abingdon-Island Tortoise (*Testudo abingdonii*), from the Galapagos Islands, new to the Collection, purchased on January 12th.

1 Queensland Long-necked Terrapin (*Chelodina expansa*), from Queensland, new to the Collection, purchased on January 19th.

A Hybrid Sea-Lion.

Mr. GEORGE JENNISON sent for exhibition a mounted specimen of a hybrid Sea-Lion (*Otaria pusilla* ♂ × *O. californiana* ♀), which had been born in the Belle Vue Gardens, Manchester, together with photographs of another specimen now living in the same Gardens, and the following notes:—

“Both the parents, *O. pusilla* ♂ and *O. californiana* ♀, arrived here as immature specimens. The male had been over four years, the female six years in the Collection when the first pup was born in June, 1911. It was found dead. The next one, in 1912, lived only about a day. It was taken from the parents who were tossing it about. The keeper (J. Craythorne) came to the conclusion that the ill-treatment was nervousness and excessive solicitude, and accordingly separated the female a few days before the next birth was expected, and prepared a corner fenced from the water into which he took the pup—they are always born on land—when it was born on June 15th, 1913. The mother followed the little

one, pushed the pup with her head until it found the teats, and the rearing has presented no difficulty. A few interesting features presented themselves.

"On June 21st I had the partition removed, and the pup immediately went into the water and continued to return there, although the mother threw it out by the neck repeatedly, finally in so rough a manner as to endanger its life. June 28th, the pup climbed over the two-foot fence. This was then raised to three feet, which was beyond its powers. The keeper tells me that on July 2nd the mother carried the pup by the neck to the water, kept it in the tank and on the side for half an hour, and then carried it back to the safe retreat. Neither then nor subsequently did I see this interesting sight. And later the mother seemed rather careless of the young one when in the water. An occasional bath seemed necessary, and as the little one had no notion of surmounting the three inches from the water to the side of the bath, the keepers had to watch his swim—he is a male—and then lift him out, a duty that increased in difficulty as he grew stronger and, strangely enough, more shy.

"At five months old it learned to leap out. At six months it began to play with fish given to the mother, and after a fortnight it ate a little. It still sucks. It is very lively in the water, fond of swimming on its back and stroking its nose with the fore flippers, a trait common to Cape Sea-Lions which I have never noticed among the Californians. The pup has a pearly-grey pelage; the head is round and well bombed, and the whole animal bears a close resemblance to the male parent.

"The adult animals are kept in the open with free access to a shelter which they never use.

"The male is usually in the water and generally drives the female out very quickly. This hostility is suspended in severe weather, when both animals swim continually to keep the ice from forming."

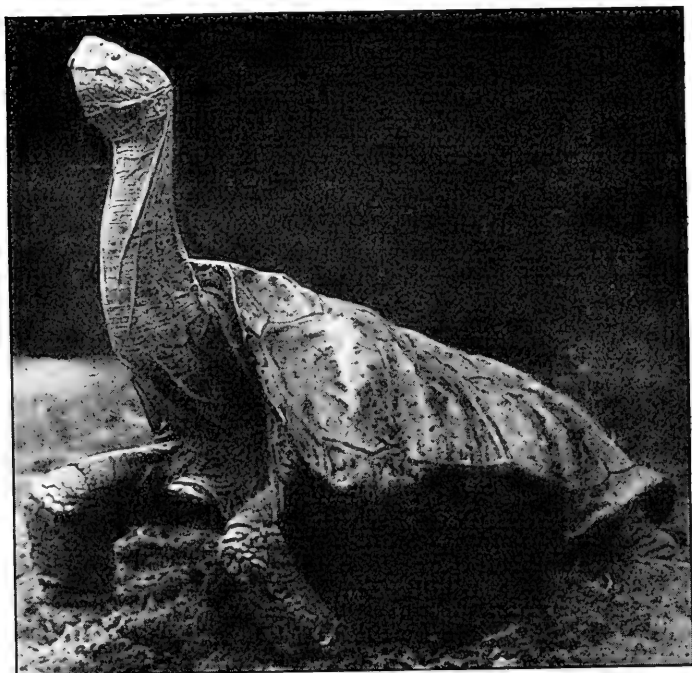
Giant Saddle-backed Tortoise.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a photograph (text-fig. 1) of a female example* of the Giant Saddle-backed Tortoise (*Testudo abingdonii*), recently purchased by the Society. On the arrival of the tortoise, the origin of which was unknown, Mr. Boulenger was somewhat puzzled as to the species to which it should be referred, but, on carefully comparing it with the Saddle-backed Tortoises in the British Museum, came to the conclusion that the specimen was none other than the hitherto unknown female of *T. abingdonii*, a species which had never previously been brought to Europe alive, and which was thought to be extinct. An inspection of the very representative collection of Giant Tortoises in the Tring Museum strengthened the conclusion arrived at.

* [The tortoise has since died, and turned out to be a male.—EDITOR, P. Z. S.]

From the few male specimens in museums this tortoise differs by the fore part of the shell being less strongly compressed and not reaching the same height, more as in *T. ephippium*, by the comparatively greater breadth of the hinder part of the carapace, by the broader bridge, and by the smaller size of the marginals bordering the bridge.

Text-figure 1.

Giant Saddle-backed Tortoise (*Testudo abingdonii*).

<i>Measurements.</i>		Inches.
Length of carapace in straight line	25	
Length of carapace over curve	27	
Width of carapace in straight line.....	17	
Width of carapace over curve.....	27	
Width of hinder part of carapace in straight line (from centre of 9th marginal).....	} 17	
Width of hinder part of carapace over curve		20 $\frac{1}{2}$
Vertical height in front		9 $\frac{3}{4}$
Length of plastron		19
Width of plastron		16 $\frac{1}{2}$
Width of bridge		10
Depth of marginals, bordering bridge		4

Mr. Boulenger pointed out that the neck, which exactly equalled the shell in length, was not as represented in the single stuffed specimen in the British Museum, without any folds, but that the skin was loose, with numerous folds, a pair of very strong lateral ones extending from the sides of the head down almost the entire length of the neck.

The tortoise, although very lively, is extremely shy, and on one's approach has the peculiar habit of withdrawing its head, standing as high up as possible on its hind limbs, and bending over until the fore part of the carapace almost touches the ground. The purpose of this performance seems to be in order to protect the head and neck which, owing to the peculiar shape of the front part of the shell, remain completely exposed on withdrawal.

The shell in this species being of extraordinary thinness and lightness, the creature is able to progress at a pace which, compared with that of the other tortoise in the collection, is remarkable for its rapidity.

Helminthes of the British Antarctic Expedition, 1910-1913.*

Dr. R. T. LEIPER, M.B., F.Z.S., and Surgeon E. L. ATKINSON, R.N., gave a lantern demonstration of the Helminthes collected by the British Antarctic ('Terra-Nova') Expedition, 1910-1913. In all, thirty-seven species of Helminthes were collected by Surgeon Atkinson on the voyage of the 'Terra-Nova,' and whilst a member of the shore party. One species was a free-living Nematode, *Leptosomatium setosum*, the remainder were parasitic. Of these latter,

8 species had been recorded from the Antarctic zone, viz. :—

In *Leptonychotes weddelli*:

Ascaris osculata Rud.

Ascaris radiata v. Linstow.

Ascaris rectangula v. Linstow.

Corynosoma antarcticum Rennie (= *C. hamanni* v. L.).

Dibothriocephalus mobilis Rennie & Reid.

Dibothriocephalus coatsi Rennie & Reid.

Diphyllobothrium perfoliatum Railliet & Henry.

In *Aptenodytes forsteri*:

Anomotenia zederi (Baird).

Free-living Nematode:

Leptosomatium setosum v. Linstow.

* From the Helminthological Department of the London School of Tropical Medicine.

3 species previously found in the Arctic zone are now recorded from the Antarctic for the first time, viz. :—

In *Megaptera longimana* ;

Filaria crassicauda Creplin.

Echinorhynchus turbinella Dies.

In *Leptonychotes weddelli* :

Ogmogaster plicatus (Creplin). This species is a parasite of whales in northern seas.

1 species recorded outside the Antarctic zone has now been found within the Circle, viz. :—

In *Megalestris maccormicki* :

Tetrabothrius cylindraceus Dies.

15 species found within the Antarctic circle are new, viz. :—

NEMATODA.

KATHLEENA SCOTTI, sp. n., from *Diomedea melanophrys*.

An Ascarid nearly related to *Ascaris osculata* which is designated type, *infra*, of a new genus *Kathleena*.

Whitish, firm, round-worms. Male 15×0.9 mm. Female the same or slightly larger. Interlabia very large, pentagonal. Short-curved œsophageal appendage 0.2 mm. Intestinal cæcum 1.8 mm. Œsophagus 2.53×0.4 mm. Spicules 3×2.7 mm. Tail of male terminates in blunt digitate process.

ACANTHOCEPHALA.

ECHINORHYNCHUS CAMPBELLI, sp. n., from *Trematomus bernacchii*.

Male 9 mm. Female 10 mm. Thin-walled. 2.5 mm. broad. Proboscis 2 mm. Hook-bearing rostellum 0.5 mm. Hooks 14 linear series of 8 hooks each. Testes oval, occupy the third fourth of the body.

ECHINORHYNCHUS RENNICKI, sp. n., from *Trematomus bernacchii*.

Male 3.7 mm. Female 4 mm. Proboscis 1 mm. Hook-bearing rostellum 0.3 mm. Hooks in 12 linear series of 6 each. Those of alternate rows are in line transversely. Each hook protrudes from a transparent cuticular lapel. Lemnisci are long and slender.

ECHINORHYNCHUS DEBENHAMI, sp. n., from *Trematomus bernacchii*.

Male 2.2 mm. Female 2.2 mm. Sickle-shaped. Stout, cylindrical rostellum with hooks in 12 linear series of 6 each. Lemnisci bag-like, extending but little behind proboscis. Testes large, occupying anterior half of body-cavity, deeply lobed. Female crowded with eggs.

TREMATODA.

HEMIURUS OATESI, sp. n., from *Trematomus bernacchii*.

Length 2 mm. Abdomen present but retracted wholly. Skin sharply striated. Ventral sucker 0.34 mm. diam., twice that of oral sucker. Enormous muscular seminal vesicle. Yolk-masses compact, lobulated. Eggs exceedingly numerous and small.

APONURUS BOWERSI, sp. n., from *Trematomus bernacchii*.

Length 1 mm. Oral sucker has characteristic fleshy lip along dorsal rim only. Gut-branches greatly dilated extend to posterior end of body. The yolk-glands are peculiar: two halfmoon-shaped solid masses lying in apposition immediately in front of the ovary.

LEPODORA GARRARDI, sp. n., from *Trematomus bernacchii*.

Flat fleshy forms 3×0.9 mm. Brownish colour due to numerous yolk-glands. Skin covered with delicate spines. Ventral sucker 0.27 mm., oral sucker 0.37 mm. Stout pyriform pharynx 0.2 mm. Eggs few but large. Testes tandem. Gut-branches wide and extending to posterior end of body.

PODOCOTYLE PENNELLI, sp. n., from *Trematomus bernacchii*.

Small forms tapering from large pouting ventral sucker. Armed cirrus extends to posterior level of the ventral sucker. Yolk-glands large and discrete. Testes smooth, tandem. Eggs large, with flat knob-like protrusion at one pole.

ALLOCREADIUM FOWLERI, sp. n., from *Trematomus bernacchii*.

Immature forms 0.74 mm. in length, 0.4 mm. broad. Skin smooth. Cylindrical excretory vesicle with fine black pigment granules. Large ventral sucker 0.36 mm. Three small round bodies 0.1 mm. in diam. represent the genital glands.

CESTODA.

DIBOTHRIOCEPHALUS LASHLEYI, sp. n., from *Leptonychotes weddelli*.

3 to 4 cms. Young segments quadrate. Mature segments 3 to 4 times longer than broad. Head 1.2 mm. long \times 0.77 mm. broad. Suckers, situated laterally, are almost circular and do not extend much down the head. Eggs commence at 14th segment, 0.06 mm. The testes extend inward in each segment in single series of three.

DIBOTHRIOCEPHALUS ARCHERI, sp. n., from *Leptonychotes weddelli*.

6 to 12 cms. Large square head 2.04 mm. broad. Lips of the suckers folded inwards. Eggs start at 57th segment and measure 0.07 mm. Testes scattered diffusely.

DIPHYLLOBOTHRUM RUFUM, sp. n., from *Leptonychotes weddelli*.

3 to 6 cms. The head is characteristically pigmented brick-red around the base of the suckers. Head measures 1.64×1.44 mm.

Suckers are dorsal and ventral. The segments overlap markedly as in *D. perfoliatum*. Eggs measure 0.025 mm.

ORIANA WILSONI, gen. et sp. n., from *Balenoptera borealis*.

Segments all immature. Strobila 13 cms. Head discoidal, 3 mm. in diam., quadrate in outline, 4 round suckers present terminally. Neck very slender. Testes arranged in two definite groups of 7-8 and 17-18. Near to *Diplobothrium*.

TETRABOTHRIUS WRIGHTI, sp. n., from *Pygoscelis adeliae*.

Strobila 2.2 mm., but none contains eggs. Head 0.4 mm. in length. Testes constantly twelve, auricular appendages of suckers well developed.

ANTHOBOTHRIUM WYATTI, sp. n., from *Trematomus bernacchii*.

Small scolices, unsegmented. Four large auricular appendages each occupied by two tandem suckers. A bright pigmented band crosses the neck in the living state.

9 species were collected in Tropical and Temperate Zones during the voyage of the 'Terra-Nova.' Of these three have been recorded previously, viz. :—

ABOTHROS CARCHARIAS and a larval *TETRAHYNCHUS* from *Carcharias* sp., and *TETRABOTHRIUS HETEROCLITUS* Dies. from *Puffinus cinereus*.

Five Cestodes, all of the genus *TETRABOTHRIUS*, are new, viz. :—

TETRABOTHRIUS CREANI, sp. n., from *Æstrelata trinitatis* and *Æ. arminjoniana*.

Strobila 4.5 cms. Head 0.84 mm. broad, carries four suckers but no rostellum. Testes are numerous. Yolk-gland large. Cirrus 0.06 mm.

TETRABOTHRIUS CATHERINÆ, sp. n., from *Æstrelata trinitatis*.

Stouter than preceding. Head comparatively small. Suckers most on top of head. Segments overlap succeeding segments by one-third. Testes 30 to 45, bunched in middle of segment. Genital organs very characteristic. Cloaca divided into outer and inner portions. There is a large pyriform seminal vesicle internal to the cirrus.

TETRABOTHRIUS AICHESONI, sp. n., from *Æstrelata trinitatis*.

Strobila 3 cms. More slender than preceding. Segments more uniform, only overlap slightly. Testes arranged in three distinct sets, are very numerous, far in excess of those of the previous forms.

TETRABOTHRIUS PRIESTLEYI, sp. n., from a Frigate-bird (*Fregata aquila* or *F. ariel*).

Strobila 10 cms., excessively slender with large tulip-like heads. Testes 17-20. Near to *T. pelecani* Fuhrmann.

TETRABOTHRIUS NELSONI, sp. n., from *Phæbetria palpebrata*.

Fragments only. Head absent. Testes 6 to 8, clumped at opposite side of segment from the cirrus.

One Nematode is new and the type of a new genus:—

TERRANOVA ANTARCTICA, from *Mustelus antarcticus*.

A single Ascarid female 32 mm. long. Three squat fleshy lips with paired anterior lobes. No labia intermedia. Œsophagus without appendage. The intestine has a long cæcum. The anus lies at the base of a deep sulcus.

The following new genera are proposed:—

CRASSICAUDA, gen. n., for *Filaria crassicauda* (Creplin), t. sp.

TERRANOVA, gen. n., for *Terranova antarctica*, sp. n., t. sp.

An Ascarid with three large simple lips. No interlabia. Œsophagus simple. Gut with anterior cæcal prolongation. No œsophageal appendage.

KATHLEENA, gen. n., for *Ascaris osculata* Rud., t. sp.

An Ascarid with three large fleshy lips and three interlabia. Œsophagus has a solid appendage and the intestine has an anterior cæcal prolongation. In this genus may also be placed *Ascaris radiata*, *A. rectangula*, and *K. scotti*.

ORIANA, gen. n., for *Oriana wilsoni*, sp. n., t. sp. (*vide supra*).

Cyclophyllid with large quadrate discoidal head carrying four round suckers. Rostellum absent.

The types of the above forms are in the British Museum (Natural History), London. An illustrated account of the collection will appear in one of the zoological volumes of the results of the Expedition, to be published by the Trustees of the Museum.

March 3, 1914.

Prof. E. W. MACBRIDE, M.A., D.Sc., F.R.S., Vice-President,
in the Chair.

Mr. C. TATE REGAN, M.A., F.Z.S., reported on the fresh-water fishes from Dutch New Guinea collected by the British Ornithologists' Union and the Wollaston Expeditions. *Symbranchus bengalensis* was obtained for the first time in New Guinea. The collections included examples of two species of Melanotæniine Atherinids, and Mr. Regan had revised this group of fishes.

This paper will be published in the 'Transactions.'

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

February 3rd, 1914.

Sir JOHN ROSE BRADFORD, K.C.M.G., D.Sc., F.R.S.,
Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the months of November and December, 1913.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a photograph of two hybrids between a Peacock and a hen Guinea-fowl which were bred in Germany and were now in the Berlin Zoological Gardens, and remarked that there were three or four cases on record of such hybrids being produced, whereas there were only two instances known of the Peafowl crossing with the domestic fowl, and none, so far as he knew, with birds of any other genus.

Mr. Seth-Smith also showed the skin of a hybrid Pheasant hen, which had been sent him by Mr. H. J. Elwes, F.R.S. This bird was one of a number bred in Sussex by Mrs. Johnstone, between a cock *Calophasis mikado* and hen *C. ellioti*. It bore a very strong resemblance to the female *C. mikado*, but showed a trace of the black throat and rufous barring to the tail of *C. ellioti*.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., gave an account of the collections of Batrachians and Reptiles made by the British Ornithologists' Union and the Wollaston Expeditions in Dutch New Guinea. Four species of Batrachians and eight species of Reptiles were described as new.

This paper will be published in the 'Transactions' in due course.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six shillings* per annum, payable in advance.

Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper containing further observations upon the Cestode genus *Urocystidium* Beddard, in which he described more fully, from fresh material, the structure and life-history of this genus of Tapeworms.

Mr. H. G. PLIMMER, F.R.S., F.Z.S., Pathologist to the Society, reported on the Deaths which had occurred in the Society's Gardens during 1913, and on the Blood-parasites found during the same period, and illustrated his communication with an interesting series of lantern-slides.

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 17th, 1914, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

Dr. R. T. LEIPER, M.B., Ch.B., F.Z.S., and Surgeon ATKINSON,
R.N.

Lantern demonstration of the Helminthes collected by Scott's Antarctic Expedition.

C. G. SELIGMANN, M.B., M.R.C.P., F.Z.S., and S. G. SHATTOCK.

Observations made to ascertain whether any relation subsists between the Seasonal assumption of the "Eclipse" plumage in the Mallard (*Anas boschas*) and the condition of the Testicle.

F. WOOD JONES, M.B., B.Sc., F.Z.S.

Some phases in the female Reproductive System of the Mole (*Talpa europæa*).

F. F. LAIDLAW, M.A., F.Z.S.

Contributions to a Study of the Dragon-fly Fauna of Borneo.
—Part II. The Gomphinæ and Chlorogomphinæ.

H. C. CHADWICK, A.L.S.

Note on an imperfectly-developed Specimen of *Echinus esculentus*.

C. F. U. MEEK, M.Sc., F.L.S., F.Z.S.

The Possible Connection between Spindle-length and Cell-volume.

The following papers have been received :—

Surgeon JOSEPH C. THOMPSON, U.S.N.

Further Contributions to the Anatomy of the Ophidia.

WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S.

Trematode Parasites from Animals dying in the Zoological Society's Gardens during 1911–1912.

F. J. MEGGITT, M.Sc.

The Structure and Life-History of a Tapeworm (*Ichthyotœnia filicollis* Rud.) parasitic in the Stickleback.

L. N. G. RAMSAY, M.A., B.Sc.

1. On the Annelids of the Family Nereidæ collected by Mr. F. A. Potts at Puget Sound, British Columbia, in 1911, with a Note on *Micronereis* as a Representative of the Ancestral Type of the Nereidæ.

2. On the Genera *Ceratocephale* Malmgren and *Tylorhynchus* Grube.

A. KNYVETT TOTTON.

The Structure and Development of the Caudal Skeleton of the Teleostean Fish, *Pleuragramma antarcticum*.

D. M. S. WATSON, M.Sc., F.Z.S.

On the Skull of a Pariasaurian Reptile, and on the Relationships of that Type.

H. R. HOGG, M.A., F.Z.S.

Spiders from the Montebello Islands.

Miss ALBERTINA CARLSSON.

On *Cynodictis intermedius* and *Cynodon gracilis* from the Phosphorites of Quercy.

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Report on the Mollusca collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

H. WALLIS KEW, F.Z.S.

On the Nests of Pseudoscorpiones; with Historical Notes on the Spinning-Organs and Observations on the Building and Spinning of the Nests.

C. TATE REGAN, M.A., F.Z.S.

Report on the Freshwater Fishes collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

Prof. W. J. DAKIN, D.Sc., F.L.S., F.Z.S.

Fauna of Western Australia.—I. The Onychophora of W. Australia. II. The Phyllopoda of W. Australia.

Lt.-Col. J. M. FAWCETT.

Description of Two new Species of African Sphingidæ.

GEORGE JENNISON.

Note on a hybrid Sea-Lion.

P. R. AWATI, B.A., C.I.C.

The Mechanism of Suction in the Potato Capsid Bug (*Lygus pabulinus* Linn.).

E. W. SHANN, B.Sc.

On the Nature of the Lateral Muscle in Teleostei.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W

February 10th, 1914.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

February 17th, 1914.

Prof. E. A. MINCHIN, M.A., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of January, 1914.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a photograph of a female example of the Giant Saddle-backed Tortoise (*Testudo abingdonii*) recently purchased by the Society. On the arrival of the tortoise, the origin of which was unknown, Mr. Boulenger was somewhat puzzled as to the species to which it should be referred, but, on carefully comparing it with the Saddle-backed Tortoise in the British Museum, came to the conclusion that the specimen was none other than the hitherto-unknown female of *T. abingdonii*, a species which had never previously been brought to Europe alive, and which was thought to be extinct. An inspection of the very representative collection of Giant Tortoises in the Tring Museum strengthened the conclusion arrived at.

From the few male specimens in museums this Tortoise differs by the fore-part of the shell being less strongly compressed and not reaching the same height, more as in *T. ephippium*, by the comparatively greater breadth of the hinder part of the carapace, by the broader bridge, and by the smaller size of the marginals bordering the bridge.

Mr. Boulenger also remarked upon some of the habits of this species.

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MR. GEORGE JENNISON sent for exhibition a mounted specimen of a hybrid Sea-Lion (*Otaria pusilla* ♂ × *O. californiana* ♀), which had been born in the Belle Vue Gardens, Manchester, together with photographs of another specimen now living in the same Gardens, and notes upon its habits.

DR. R. T. LEIPER, F.Z.S., and Surgeon E. L. ATKINSON, R.N., gave a lantern demonstration of the Helminthes collected by the British Antarctic Expedition (Terra-Nova), 1910-1913. The collection contained nine forms previously recorded from the Antarctic Zone, three previously recorded only from the Arctic Regions and one other previously recorded elsewhere and now found in the Antarctic Zone, and fifteen new species and four new genera. Of the forms obtained in Tropical and Temperate Zones during the voyage, three had been recorded previously and five were new species.

MESSRS. C. G. SELIGMANN, F.Z.S., and S. G. SHATTOCK communicated the results of some observations made to ascertain whether any relation subsists between the seasonal assumption of the "eclipse" plumage in the Mallard (*Anas boscas*) and the function of the testicle. The observations consisted in the microscopic examination of the testicle each month of the year, and in a study of the results of castration. The first observation showed that the passage from the eclipse to the full winter plumage was not associated with the advent of spermatogenesis. The Mallard had passed out of eclipse by September, but at this date and till early spring the spermatogenic function was in abeyance. Castration carried out during the eclipse (July and August) did not delay the assumption of the winter plumage. If carried out in December, however, the eclipse was delayed, though only for a few weeks. This delay had its parallel in the well-established fact that, if a colt is castrated when shedding its winter coat, the shedding was for a time arrested, and then proceeded only slowly.

The complete castration of birds was a difficult procedure, even under anaesthetics and after free incision and inspection of the abdominal organs. And in no instance in the case of the Mallard was no testicular tissue reproduced, though the amount was quite small.

Whilst it would appear that the seasonal change of plumage did not correspond with the spermatogenic function of the testicle, its connection with the production of an internal secretion could only be settled by castration followed absolutely without regeneration; this could be ensured only by re-opening the abdomen under an anaesthetic and removing any reproduced tissue found.

DR. F. WOOD-JONES, F.Z.S., read a paper on some phases in the reproductive history of the female Mole (*Talpa europea*). He dealt with the nature-lore connected with the sexual evolution of the Mole, the embryological development of the reproductive

system, seasonal changes in the external sexual characters of the adult female, and the character of these changes as seen in microscopical sections of embryos, nestlings, and adults.

Mr. H. C. CHADWICK contributed some notes on an imperfectly developed specimen of the Sea-Urchin (*Echinus esculentus*). Two well-marked depressions in the test attracted attention to the living animal. Denuded of the spines the test presents the appearance of a lump of plastic material which has been pinched with thumb and forefinger. Two abnormalities appear in the apical system, and abnormal plates occur in ambulacra II, III, and IV. In ambulacrum III two plates of normal composition are exceptional, in that the pore-pairs of their respective demi-plates are almost completely outside the limits of the plate, and perforate the adjoining interambulacral plate. Similar irregularities, though not so well marked, occur in ambulacrum IV.

Mr. C. F. U. MEEK, M.Sc., F.Z.S., communicated a paper entitled "The Possible Connection between Spindle-length and Cell-volume." In *Forficula auricularia*, *Helix pomatia*, and Man the ratio between the lengths of the mitotic spindle in the two spermatocyte metaphases seemed to be identical or almost identical with the ratio between the radii of two spheres, of which the volume of one is equal to twice that of the other; and, since the volume of the primary spermatocyte cell in the metaphase is presumably equal to twice that of the secondary spermatocyte, connection was suggested between the spindle-length and cell-volume at this stage. Photo-micrographs are now given, showing this ratio in the two first-named organisms; but, in the case of *Forficula*, new preparations have been observed to contain primary spermatocyte spindles of excessive lengths, and unless a satisfactory explanation can be found for these, the original suggestion must be either modified or discarded.

The study of spermatocyte cells in Man, *Triton cristatus*, *Stenobothrus viridulus*, *S. curtipennis*, *Forficula auricularia*, and *Helix pomatia* proves that the volume may be similar in widely-separated organisms, and very different in organisms that are closely allied. In the circumstances, increasing somatic complexity of the organism is not necessarily accompanied by increase of the volumes of these cells.

A paper received from Mr. F. F. LAIDLAW, M.A., F.Z.S., contained a further contribution to the study of the Dragon-fly fauna of Borneo, and dealt with the Gomphinae and Chlorogomphinae, of which a number of new species and subspecies was described.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 3rd, 1914, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

C. TATE REGAN, M.A., F.Z.S.

Report on the Freshwater Fishes collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

H. WALLIS KEW, F.Z.S.

On the Nests of Pseudoscorpiones; with Historical Notes on the Spinning-Organs and Observations on the Building and Spinning of the Nests.

H. R. HOGG, M.A., F.Z.S.

Spiders from the Montebello Islands.

D. M. S. WATSON, M.Sc., F.Z.S.

On the Skull of a Pariasaurian Reptile, and on the Relationships of that Type.

F. J. MEGGITT, M.Sc.

The Structure and Life-History of a Tapeworm (*Ichthyotania flicollis* Rud.) parasitic in the Stickleback.

WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S.

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The following papers have been received:—

Surgeon JOSEPH C. THOMPSON, U.S.N.

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L. N. G. RAMSAY, M.A., B.Sc.

1. On the Annelids of the Family Nereidæ collected by Mr. F. A. Potts at Puget Sound, British Columbia, in 1911,

with a Note on *Micronereis* as a Representative of the Ancestral Type of the Nereidæ.

2. On the Genera *Ceratocephale* Malmgren and *Tylorrhynchus* Grube.

A. KNYVETT TOTTON.

The Structure and Development of the Caudal Skeleton of the Teleostean Fish, *Pleuragramma antarcticum*.

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On the Fossil Carnivores *Cynodictis intermedius* and *Cynodon gracilis* from the Phosphorites of Quercy.

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On the Nature of the Lateral Muscle in Teleostei.

F. E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—XIII. On Two new Species belonging to the Genera *Oochoristica* and *Linstowia*, with Remarks upon those Genera.

GUY DOLLMAN.

Notes on a Collection of East African Mammals presented to the British Museum by Mr. G. P. Cosens.

W. T. CALMAN, D.Sc., F.Z.S.

Report on the River-Crabs (Potamonidæ) collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

OLDFIELD THOMAS, F.R.S., F.Z.S.

Report on the Mammals collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
February 24th, 1914.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

March 3rd, 1914.

Prof. E. W. MACBRIDE, M.A., D.Sc., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. C. TATE REGAN, M.A., F.Z.S., reported on the fresh-water fishes from Dutch New Guinea collected by the British Ornithologists' Union and Wollaston Expeditions. *Symbranchus bengalensis* was obtained for the first time in New Guinea. The collections included examples of two species of Melanotæniine Atherinids, and Mr. Regan had revised this group of fishes.

This paper will be published in the 'Transactions.'

Mr. H. WALLIS KEW, F.Z.S., contributed a paper "On the Nests of Pseudoscorpiones: with Historical Notes on the Spinning-Organs and Observations on the Building and Spinning of the Nests." The paper described the nests in which these animals enclose themselves for moulting, for brood-purposes, and in some cases for hibernation. They are closed cells of spun tissue, with or without a covering of earthy or vegetable matters. The tissue is of innumerable threads crossed and coalesced irregularly, without interspaces, and almost like silk-paper. With regard to the spinning-apparatus, confusion has existed; but the Author's observations on living animals place it beyond doubt that the cephalothoracic glands, whose ducts traverse the chelicerae to near the apex of the movable finger and open in the galea, or in the

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tubercle which replaces it in some groups, are the organs concerned. Contrary to previous statements, the "combs" of the chelicerae have nothing to do with the silk. The manner in which the nests are built and spun was described in detail. The spinning was associated with forward and backward movements of the body and with lateral movements of the chelicerae; and the silk issued from the galea or tubercle in several viscid, very fine threads. The methods of three species, representing both main divisions of Pseudoscorpiones, were observed; and, being essentially identical, were believed to be characteristic of the order.

Mr. H. R. HOGG, M.A., F.Z.S., read a paper on a collection of Spiders made by Mr. P. D. Montague, of Caius College, Cambridge, supplemented by a few specimens sent by Mr. T. H. Haynes from the Montebello Islands off Onslow, on the N.W. Coast of Australia.

These islands, from geological evidence, were part of the old coast-line, though now about 90 miles away. Although the larger specimens are mostly widely spread and possibly more or less recent importations, the smaller are nearly all new species, showing evidence of a much longer separation from their congeneric relations on the mainland.

Out of seventeen species ten are new, as well as a new genus and two new varieties.

Mr. D. M. S. WATSON, M.Sc., F.Z.S., gave an account of his paper on "The Skull of a Pariasaurian Reptile and the Relationships of that Type." The skull of *Pariasaurus* is completely described therein, with the exception of the bony labyrinth of the ear. It is compared with all the members of the Order Cotylosauria which are well enough known to make a comparison of any value, and shown to differ in the very important characters of the brain-case from all of them, representing an entirely distinct branch.

The characters of the various orders of the superorder Therapsida are then detailed and the characteristics of the superorder deduced from their comparison; *Pariasaurus* is shown to possess none of them, and hence to be quite unconnected with their ancestry.

A sphenethmoid is recognised in *Pariasaurus* for the first time in any reptile, and the homologies and distinguishing features of the single temporal bone, the squamosal, are discussed.

Mr. F. J. MEGGITT, M.Sc., contributed a paper, communicated by Prof. F. W. GAMBLE, F.R.S., F.Z.S., containing a description of a Tapeworm parasitic in the Stickleback (*Gasterosteus aculeatus*), with an account of its anatomy and histology, and its life-history.

DR. WILLIAM NICOLL, M.A., D.Sc., F.Z.S., sent a paper dealing with the Trematode Parasites obtained from animals that had died in the Society's Gardens during 1911-912, in which he described four new genera and eleven new species.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 17th, 1914, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

L. N. G. RAMSAY, M.A., B.Sc.

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A. KNYVETT TOTTON.

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G. C. ROBSON.

Report on the Mollusca collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

P. R. AWATI, B.A., D.I.C.

The Mechanism of Suction in the Potato Capsid Bug (*Lygus pabulinus* Linn.).

K. G. BLAIR, B.Sc., F.E.S.

Coleoptera Heteromera collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

R. LYDEKKER, F.R.S., F.Z.S.

The Malay Race of the Indian Elephant.

Prof. W. J. DAKIN, D.Sc., F.L.S., F.Z.S.

Fauna of Western Australia.—I. The Onychophora of W. Australia. II. The Phyllopoda of W. Australia.

The following papers have been received :—

Surgeon JOSEPH C. THOMPSON, U.S.N.

Further Contributions to the Anatomy of the Ophidia.

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Report on the Mammals collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

H. A. BAYLIS.

Report on the Nematodes and Gordiacea collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

The Rev. T. R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

Crustacea from the Falkland Islands collected by Mr. Rupert Vallentin, F.L.S.—Part 2.

Communications intended for the Scientific Meetings should be addressed to

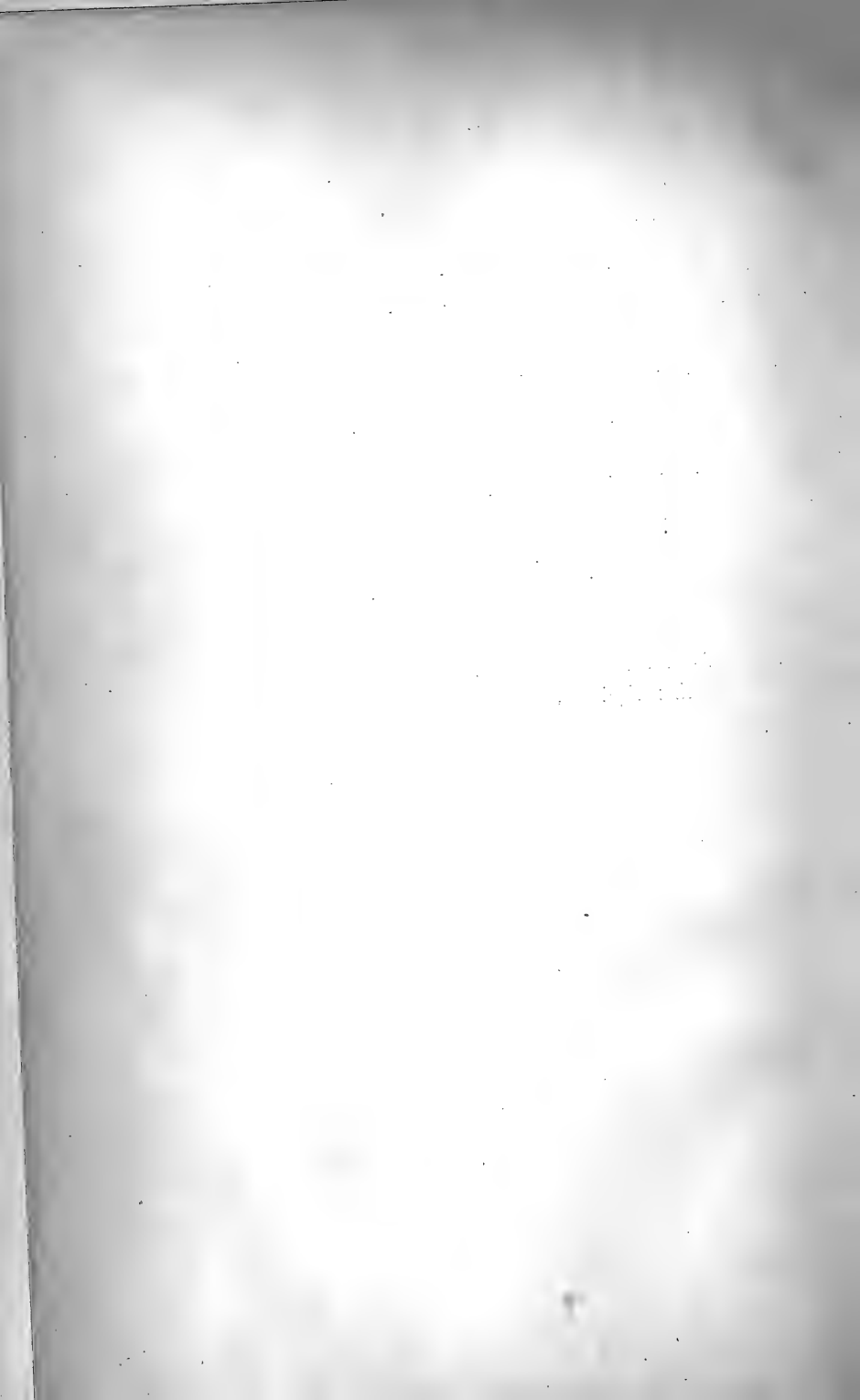
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Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

March 10th, 1914.



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The 'Proceedings' for the year are issued in *four* parts, *paged consecutively*, so that the complete reference is now P. Z. S. 1914, p. . . . The Distribution is as follows:—

Part	I.	issued in March.
"	II.	" June.
"	III.	" September.
"	IV.	" December.

'Proceedings,' 1913, Part IV. (pp. 861-1104), were published on December 17th, 1913.

The Abstracts of the 'Proceedings,' Nos. 127-129, are contained in this Part.

PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.
1914.

PART II.
CONTAINING PAGES 227 TO 490, WITH 26 PLATES
AND 47 TEXT-FIGURES.

JUNE 1914.

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ZOOLOGICAL SOCIETY OF LONDON.

THIS Society was founded in 1826 by Sir SEAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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The Society consists of Fellows, and Honorary, Foreign, and Corresponding Members, elected according to the By-Laws. It carries out the objects of its foundation by means of the collection of living animals, by its Library, and by its Scientific Publications.

The Office of the Society, Regent's Park, N.W., where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at ONE P.M.

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The Library is closed from Good Friday to Easter Monday, and upon all other Bank Holidays. It is also closed annually for cleaning purposes during the whole month of September.

The Meetings of the Society for General Business are held in the Meeting Room at the Society's Office on the third Wednesday in every month of the year, except in September and October, at half-past Four o'clock P.M.

The Meetings for Scientific Business are held in the Meeting Room at the Society's Office fortnightly on Tuesdays, except in July, August, September, and December and January, at half-past Five o'clock P.M.

The Anniversary Meeting is held on the 29th. of April, or the nearest convenient day, at Four P.M.

The Society's Gardens are open daily from Nine o'clock until Sunset. Mr. R. I. Pocock, F.R.S., F.L.S., is the resident Superintendent and Curator of Mammals, Mr. D. Seth-Smith is Curator of Birds and Inspector of Works, Mr. E. G. Boulenger is Curator of Reptiles, and Prof. H. M. Lefroy is Curator of Insects. The Prosectorium for Anatomical and Pathological work is under the charge of Mr. Frank E. Beddard, M.A., D.Sc., F.R.S., Prosector, assisted by Mr. H. G. Plimmer, F.R.S., M.R.C.S., Pathologist to the Society.

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FELLOWS also have the privilege of subscribing to the Annual Volume of 'The Zoological Record,' which gives a list of the Works and Publications relating to Zoology in each year, for the sum of One Pound Ten Shillings. Separate divisions of volumes 39 to 42 can also be supplied. Full particulars of these publications can be had on application to the Secretary.

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Any FELLOW, having paid all fees due to the Society, is at liberty to withdraw his or her name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with "The Secretary."

P. CHALMERS MITCHELL,

Secretary.

Regent's Park, London, N.W.

June, 1914.

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FOR
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1914.

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The "Proceedings" for each year are issued in four parts, pagged consecutively, during the months of March, June, September, and December. From January 1901 they have been issued as two half-yearly volumes, indexed separately.

An "Abstract of the Proceedings" is published by the Society on the Tuesday following the date of the Scientific Meeting to which it refers. It is issued along with the "Proceedings," free of extra charge, to all Fellows who subscribe to the Publications, but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post free for the sum of Six Shillings per annum, payable in advance.

The "Transactions" contain such of the communications made to the Scientific Meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

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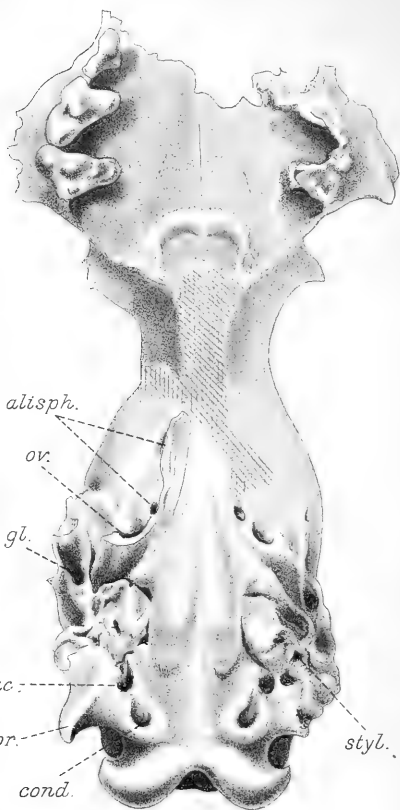
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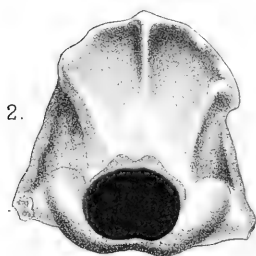


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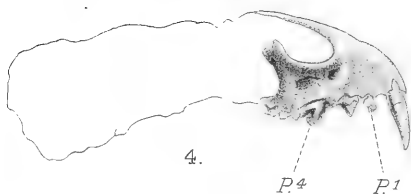
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1-3. *CYNODICTIS INTERMEDIUS*.
4, 5. *CYNODON GRACILIS*.

West, Newman lith.

PAPERS.

13. On the Fossil Carnivores *Cynodictis intermedius* and *Cynodon gracilis* from the Phosphorites of Quercy. By ALBERTINA CARLSSON*, Zootomical Institute, University of Stockholm.

[Received December 23, 1913: Read April 21, 1914.]

(Plate I.†)

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Among the fragmentary fossils of Carnivora from the Phosphorites of Quercy which belong to the collections of the Zootomical Institute in Stockholm, and which Professor Leche has requested me to examine, there were two which excited my special interest.

CYNODICTIS INTERMEDIUS. (Pl. I. figs. 1-3.)

One was a part of a skull, consisting of the well-preserved brain-case and a fragment of the face. In the Catalogue it is designated No. 2216, *Cynodictis* sp. Comparing it with the descriptions of Filhol (1, p. 116) and Schlosser (4, pp. 40 & 47), I have identified it as *Cynodictis intermedius*.

As we know very little about the skull of this species, or about that of most species of the same genus—Filhol knows only the foremost part of the face,—I will here give its characters.

The skull in question belongs to an adult animal, for only the sutures between the squamosals and the frontals, as well as those between the basioccipital and the basisphenoid, can be seen.

The head, which, as in other forms of *Cynodictis*, is long and not very broad, has a brain-case which, in its narrow and elongated form, resembles more that of the recent Viverridæ than that of the now living Canidæ (fig. 1).

Filhol (1, p. 72) says of *Cynodictis boriei*:—"La masse cérébrale devait être proportionnellement petite par rapport à la taille de l'animal." As in *Cynodictis gryei* (1, pl. 19), the face seems to be comparatively more developed than the brain-case, the frontals—if it is allowed to judge from the distance between the orbits—being comparatively broader than in the Viverridæ. The crista sagittalis has attained a much higher degree of development than in Viverridæ and Canidæ of the same size. As in the Viverridæ, the crista occipitalis is high, and consequently the height of the supraoccipital is considerable (fig. 2).

* Communicated by OLDFIELD THOMAS, F.R.S., F.Z.S.

† For explanation of the Plate see p. 230.

As in the Canidæ, the foramen condyloideum (fig. 3, *cond.*) is situated far behind the foramen lacerum posterius (*lac.*); in the Viverridæ, as is well known, these foramina open into a common fossa, separated from each other only by a bony bridge. Also, with regard to the foramen glenoideum, the skull in question agrees with that of the Canidæ, this foramen being here rather distinct; in the Viverridæ it is represented by an extremely small opening.

The canalis alisphenoideus (*alisph.*) is longer in *Cynodictis intermedius* than in the two above-mentioned families, and consequently the alisphenoid is of greater length in the former than in the latter. Below the posterior nares the border of the palatines terminates in a ridge; such a ridge is not to be seen in the Canidæ or in the Viverridæ, but is found, more or less developed, in *Propithecus*, *Erinaceus*, *Perameles*, *Myrmecobius*, and *Sinopa* (3). The bullæ osseæ are not preserved, probably on account of having been loosely attached to the skull, as they are still found in young bears and in *Paradoxurus*. No doubt they were ossified, as is the case in *C. boriei* and *C. gryei* (1, pp. 73 & 79). From the form and the direction of the processus par-occipitales (*pr.*), it appears that they have not, as in the Viverridæ, been spread over the hinder surface of the bullæ, but have been separated from them as in the Canidæ.

The petrous bone is pear-shaped; on its lateral side there is a deep fossa. As the foramen stylomastoideum (*styl.*) opens into it, it must be formed by a portion of the mastoid.

Thus the skull of *Cynodictis* agrees partly with the Canidæ and partly with the Viverridæ. Though in most respects it agrees with the former, especially with regard to the basis cranii, the form of the brain-case indicates kinship with the latter. Such a kinship has been stated before by Filhol on account of the result of his examination of the teeth and the tooth-formula of the lower jaw of several species of *Cynodictis*.

CYNODON GRACILIS. (Pl. I. figs. 4, 5.)

The other fragment was part of a skull of *Cynodon gracilis* designated No. 1621. Of this species Filhol has described only the lower jaw (1, p. 120); the skull was as yet unknown. A short description of the fragment in question may therefore be of interest. It consists of a tolerably well-preserved part of the face; on the right side the anterior part of the zygomatic arch remains, on the left it is totally absent. The brain-case is not entire, but its length and outlines can be seen. Of the basis cranii, the portion of the basisphenoid which borders on the pterygoids was preserved.

Of the lower jaw there are four fragments of different size; in two of them the three posterior premolars and the two anterior molars are found; a left half of the lower jaw shows

the alveoli of \overline{C}_1 , \overline{P}_1 , \overline{P}_2 , and fragments of \overline{P}_3 , \overline{P}_4 , and \overline{M}_1 ; a right half contains the canine, the premolars, and the molars. The small size of the examined object is very remarkable. According to Filhol (1, p. 12), \overline{P}_4 measures 5.5 and \overline{M}_1 8 mm. in length; however, I found that the corresponding teeth measure 4 and 5.5 mm. respectively. But it must be borne in mind that, according to Schlosser (4, p. 54), in the specimen of *Cynodon gracilis* in the Museum of Munich, \overline{M}_1 is not quite as long as that of the specimen examined by Filhol, and that there is a possibility that this skull belonged to a female or to a small specimen. How widely the size of the skull of Carnivora varies has been shown by Hensel (2).

That we have here to do with *Cynodon gracilis*, and not with *C. velauinus*, *C. aimardii*, *C. speciosus*, or *C. leptorhynchus*, is evident, as all these, which also occur in the Phosphorites of Quercy, are larger than *C. gracilis*.

The sutures between the maxillaries and the frontals, those between the latter and the nasals, those between the jugal and the maxillary, as well as the outlines of the lachrymal, and those of the orbitosphenoid are very distinct—showing that the specimen is young. There is, however, a crista sagittalis (fig. 5). In *Cynodon gracilis* the canalis infraorbitalis opens above \overline{P}^3 , in *Cynodon leptorhynchus*, according to Schlosser (5, p. 115), above the interspace between \overline{P}^3 and \overline{P}^4 , which probably depends on the greater length of the jaws of the latter. The nasals are very short, and consequently the anterior nares have an oblique direction as in *Cynodictis gryei*, and as in the last-mentioned animal the nasals stretch between the frontals above the maxillaries (1, pl. 19. fig. 58). Judging from the strength and direction of the preserved part of the jugal, the zygomatic arch seems to have been strong and wide, thus differing from that of *Cynodon leptorhynchus*, of which Schlosser states:—"Jochbogen schlank, wenig gekrümmt" (5, p. 115).

The upper incisors are separated by small gaps. The upper C measures 7.5 mm. in height; \overline{P}^1 has one root, and stands at some distance from the canine. \overline{P}^2 and \overline{P}^3 are of the same form as \overline{P}_2 and \overline{P}_3 , but of smaller size. As to \overline{P}^4 , it has a strong cingulum, as have the anterior premolars; its anterior cusp is higher than the posterior. Only its labial side was to be seen, which was also the case with \overline{M}^1 and \overline{M}^2 . The height of the two latter teeth is 5 mm. (fig. 4).

The lower jaw and its teeth have been most satisfactorily described by Filhol (1, p. 120).

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EXPLANATION OF PLATE I.

Cynodictis intermedius.

- Fig. 1. Skull, upper view. 1/1 nat. size.
 2. Skull, seen from behind. 1/1 nat. size.
 3. Basis cranii. 1/1 nat. size.

alisph. Canalis alisphenoides; *cond.* Foramen condyloideum;
gl. Foramen glenoideum; *lac.* Foramen lacerum posterius;
ov. Foramen ovale; *pr.* Processus paroccipitalis; *styl.* Foramen
 stylomastoideum.

The hatched parts of the figures represent lost portions
 replaced by cement.

Cynodon gracilis.

- Fig. 4. Part of the skull, right view. 1/1 nat. size.
 Only the roots of $\underline{M^1}$ and $\underline{M^2}$ are left. The top of $\underline{P^3}$ is lost.
 5. Part of the skull, upper view. 1/1 nat. size.

14. On the Genera *Ceratocephale* Malmgren and *Tylorhynchus* Grube. By L. N. G. RAMSAY, M.A., B.Sc., Carnegie Research Scholar, Christ's College, Cambridge*.

[Received December 12, 1913: Read March 17, 1914.]

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Along with the Nereidæ which he collected at Puget Sound in 1911, Mr. F. A. Potts recently handed over to me some specimens of *Ceratocephale osawai* from the Sumida River, Tokyo, Japan. The general facies of these worms recalled irresistibly to my mind Grube's figures of *Tylorhynchus chinensis*, in his paper on the Annelids of the 'Novara' Expedition (1867). Reference to the literature shows conclusively that the two species are identical.

The object of this note, then, is to draw attention to this fact, and to indicate the characters and relationship of the two genera more clearly than these have hitherto been recognized.

The identity of Tylorhynchus chinensis with Ceratocephale osawai.—Izuka, discussing the systematic position of *C. osawai* in his original description of the species, remarks that he refers it to the genus *Ceratocephale* tentatively, in preference to creating a new genus for it (1903, p. 3). If we are to regard *Tylorhynchus* as a distinct genus (and there appears to be sufficient ground for this) Izuka's hesitation was fully justified. It is probable that only lack of access to Grube's paper prevented him from recognizing the true position of the species.

The facts are as follows:—The Japanese specimens (Izuka's full description is illustrated by numerous excellent figures) agree in every way with those described by Grube† from Shanghai—as to parapodia, setæ, general form, prostomium and its appendages; but they differ in the fact that the basal ring of the proboscis is devoid of papillæ, while those on the dorsal surface of the maxillary ring are less numerous.

Among the specimens at present before me, however, three which have the proboscis everted exhibit a number of large swollen papillæ or protuberances on the basal ring, corresponding approximately to those figured by Grube, while the condition of

* Communicated by Dr. A. E. SHIPLEY, F.R.S., F.Z.S.

† Grube's description is fully detailed, and is accompanied by figures by A. Afsmann, which are far above the usual standard of the figures accompanying this authority's papers.

the maxillary ring is intermediate between those described by Grube and Izuka. Moreover, the smallest of these three specimens (which are all in the heteronereid state) has these papillæ distinctly less swollen and conspicuous than the two larger ones. It is to be noted that Izuka's specimens were from the same locality as these (the Sumida River).

Further, Izuka himself (1903, p. 9) states that the papillæ on the neural surface of the maxillary ring seem to increase in number with the age of the individual, and that in larger specimens their number varies from 17 to 27.

Further still, Izuka describes the proboscis of the worm in the nereid-form only, while Grube's specimens as they are figured were in the heteronereid condition. It is conceivable that as the worms assume the heteronereid form, the changes in the posterior region of the body may be accompanied by some swelling of the areas between the deep furrows which exist in the basal ring in the immature form. Unfortunately, none of the immature specimens at present before me has the proboscis everted, and the method of examination by slitting open this organ does not give very satisfactory results, owing to the difficulty of recognizing the soft papillæ in the compressed condition resulting from the inverting of the proboscis.

It appears, therefore, that there is no ground for even the specific separation of *chinaensis* and *osawai*, and the latter name must therefore stand as a synonym of *Tylorhynchus chinensis* Grube.

The relationship of the Genera Ceratocephale and Tylorhynchus.—These genera were described independently by Malmgren and Grube in the year 1867. Since that year, various authorities have mentioned them in their schemes of classification of the Nereidæ, but their characters, especially those of *Tylorhynchus*, do not appear to have been properly comprehended. Matters were further confused when a species of the latter was referred to the former genus by Izuka in 1903, as explained above.

We must first consider whether the two genera should be regarded as distinct. On this head I think it will be agreed that the divergences are sufficient to warrant generic separation, although the two, one of which is, so far as known, confined to the Atlantic, the other to the Pacific Ocean, are certainly much more closely allied to one another than to any other genus. The chief points of difference appear to be as follows * :—

In *Tylorhynchus*,

- (a) The parapodium lacks the neuro-ligule
- (b) The neuro-cirrus is normal.
- (c) Eyes are present.

* I have not had an opportunity of examining specimens of *Ceratocephale*, which has, however, been figured and described by Malmgren (1867), McIntosh (1902), and Heimen (1911).

In *Ceratocephale*, these characters are negatived, the neuro-ligule being well-developed, the neuro-cirrus double, and eyes completely absent.

In other respects, the two show marked agreement.

The two genera appear to form a small group, diverging from the remainder of the family in the form of the parapodia, while showing some resemblance to the genera *Leonnates* and *Leptonereis* in the armature of the proboscis.

Hitherto most authors have stated that *Tylorhynchus* is characterized by the presence of hard callosities on the proboscis, as opposed to the soft papillæ of *Ceratocephale*. This is clearly due to a misapprehension of Grube's original description of *T. chinensis*, where he describes the proboscis-armature as consisting of "calli" (Latin) or "platten schwielchen." There is, however, no reason to suppose that these differ in nature from the uncornified papillæ of *Ceratocephale*, *Leonnates*, etc.

Survey of the two Genera as known up to date:—

Genus TYLORHYNCHUS Grube, 1867.

Characters.—Prostomium bearing palps, tentacles, and two pairs of eyes, as in *Nereis* L. Peristomium apodous, with four pairs of tentacular cirri. Proboscis armed only with soft papillæ, and with a pair of jaws of typical nereid form. Parapodia biramous, the rami not deeply divided, the notopodium consisting of the inferior ligule only, with setigerous lobe at its base, the superior ligule being absent. In the first two pairs the aciculum and setigerous lobe of the notopodium are absent. The noto-cirrus in the anterior region borne upon an enlarged rounded lobe; the neuropodium consisting of setigerous lobe alone, without the ventral ligule, and bearing two "lips," anterior and posterior; ventral cirrus simple. In the epitokous form no special foliaceous lobes are developed, but the original lobes are enlarged and flattened somewhat, in the middle region of the body. The setæ are homogomph and heterogomph spinigers and falcigers as in *Nereis*, but some are of slightly peculiar type. In the heteronereid cultrate setæ appear, as in *Nereis*.

Range.—Western coasts of Japan (Izuka), Shanghai (Grube). Java (Quatrefages, see below).

Species:—

T. chinensis Grube, 1867.

Syn. *Ceratocephale osawai* Izuka, 1903 and 1912.

Nereis heterocheta Quatrefages, 1865.

"Die Japanischen Palolo," Osawa, 1901.

Range.—As for the genus.

Quatrefages (1865, p. 552) described, in his 'Histoire des

Annelés,' a nereid which he called *Nereis heterocheta*, from Java. Grube (1870, p. 312) states that this description refers to *Tylorhynchus chinensis*. Quatrefages' description is not sufficient for identification, but as Grube personally examined Quatrefages' material in the Paris Museum, there is no reason for hesitation in accepting this record as a good one. As Quatrefages' description was very inadequate, and was accompanied by no figures, I have not thought it necessary to give his name preference to that of Grube.

Genus CERATOCEPHALE Malmgren, 1867.

Characters.—As for *Tylorhynchus*, except that :—

Eyes are absent.

The neuropodium bears a well-developed ventral ligule as well as the setigerous lobe.

The neuro-cirri are double, the two cirri arising from a common base.

Range.—The North Atlantic (Scandinavia : Malmgren, Heinen, Levinsen, etc.); Eastern North America (Gulf of St. Lawrence : McIntosh; Massachusetts : Verrill).

Only one species has been satisfactorily described, viz., *C. loveni* Malmgren, 1867, from the Scandinavian waters. Those from the American side may prove to be identical with this, although Verrill (1879) named his specimens *C. websteri*, without, however, giving a satisfactory diagnosis, and without figures.

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15. On the Annelids of the Family Nereidæ collected by Mr. F. A. Potts in the N.E. Pacific, in 1911.—With a Note on the Morphology of *Micronereis* as a Representative of the Ancestral Type of the Nereidæ. By L. N. G. RAMSAY, M.A., B.Sc., Carnegie Research Scholar, Christ's College, Cambridge *.

[Received December 12, 1913 : Read March 17, 1914.]

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The Annelid fauna of the Pacific coast of North America is already fairly well known, and in the present paper only one addition is made to it. This, however, is of great interest, as it is a representative of the little known genus *Micronereis*, and is apparently identical with *M. variegata* of European waters, the solitary species of the genus.

The remaining five species contained in the collection are already well known in this region; several of these are represented on the opposite shores of the Pacific by very nearly allied species, some criticism of which will be found under their various heads.

The collection also includes two examples of the remarkable and extremely interesting *Nereis cyclurus* Harr., from which some new facts as to the setæ are brought to light.

NEREIS CYCLURUS HARR.

Nereis cyclurus Harrington (4), p. 214, 1897, pls. xvi., xvii., xviii.

N. shishidoi Izuka (5), p. 177, pl. xix. figs. 10-18.

Two examples, Nanoose Bay, June 13th, 1911. Dredged in 6 fathoms, in soft mud. Commensal with hermit-crabs.

In Mr. Potts' notes these are described as of a "pale flesh-

* Communicated by Prof. J. STANLEY GARDINER, F.R.S., F.Z.S.

colour, the palps and anterior part of prostomium white, as also a prominent nuchal band. Tentacles and tentacular cirri brownish. In every segment a narrow anterior white band. Posteriorly the notopodia increase in size and become white in colour. Dorsal cirri flesh-coloured."

This remarkable species has been fully described and figured by Harrington and Johnson (6, pls. iv., v.). I have here to add only a few further notes on the setæ and some remarks on its affinities.

As to the bristles, both specimens under consideration exhibit an important feature, which has either been overlooked by other writers, or as is perhaps less probable, occurs only in some specimens. This is the occurrence of a curious homogomph falcate type of seta in the notopodial bundle of the posterior parapodia. This form of seta, which is not unlike that which occurs in the notopodium of the posterior parapodia of *N. procera* Ehl., is figured (text-fig. 1). In the larger of the two, which measures

Text-figure 1.



Homogomph falcigerous seta from notopodial bundle of 50th parapodium of *Nereis cyclurus*. $\times 200$.

75 mm. in length, with 107 pairs of parapodia, and has the characters of the peristome and parapods fully developed, these falcate setæ appear at the 32nd parapod. They are at first two in number, increasing to three or four about the 50th to 70th, and decreasing to one or two near the posterior end. The spinigers of the dorsal bundle, numerous anteriorly, decrease steadily in number, until by the 50th there are only two or three and further on none at all.

Anteriorly the lower neuropodial bundle consists entirely of falcigers, but about the same region as in the case of the notopodial falcigers, heterogomph spinigers appear in small numbers, and persist to the posterior end.

In the smaller specimen, which is about 26 mm. long with 59 setigerous segments (it is incomplete, and lacks perhaps 20 segments posteriorly), the peristome is not fully developed. The distribution of the setæ agrees exactly with that given above, the notopodial falcigers commencing about the 29th pair.

The seta-distribution in these two specimens may therefore be summarised thus:—

Region of body ...	Anterior.	Mid.	Posterior.
Notopodial bundle.	Hom. spins. (numerous).	Hom. spins. (few). Hom. falcs. (few).	Hom. spins. (rare). Hom. falcs. (1-2).
Upper neuropodial bundle.	Hom. spins. (numerous). Het. falcs. (few).	Hom. spins. (fewer). Het. falcs.	Hom. spins. Het. falcs.
Lower neuropodial bundle.	Het. falcs. (numerous).	Het. spins. (few). Het. falcs. (fewer).	Het. spins. (few). Het. falcs.

Nereis cyclurus appears to have a considerable range along the western sea-board of North America, from Southern California (Moore, 12) to Puget Sound.

Izuka has described *N. shishidoi*, a closely allied species, from the eastern side of Japan. The description is based on the solitary specimen which has been obtained there.

It is difficult to imagine what reasons Izuka can have had for separating the Japanese example as a distinct species. His description and figures, which are excellent, agree exactly with *N. cyclurus*. His only comment on the relationship of the Japanese specimen to the American ones is that *N. shishidoi* "comes nearest" to *N. cyclurus*. Harrington's description of the paragnaths of the basal ring (V-VIII) is a little difficult to understand, and this may have led Izuka to separate his specimen. Comparison, however, of the present specimens shows that the paragnaths agree exactly with those of the Japanese worm.

Harrington, after summarising the differences between *N. cyclurus* and *N. fucata* Sav., concluded that these two worms, both normally commensal with hermit-crabs, were closely related.

Moore (11, p. 343) suggests the generic separation of *cyclurus* from other nereids on account of the extraordinary peristomium.

To the present writer it seems that these authorities are both right in their way. *cyclurus* is possibly more nearly related to *fucata* than to any other species, as the form of the parapods, setæ, arrangement of paragnaths, etc., would seem to indicate. The enlarged bilobed noto-ligule in *cyclurus*, bearing the noto-cirrus below the upper lobe, is little more than an exaggerated form of the noto-ligule of *fucata*. On the other hand, the development of the peristomium in the full-grown *cyclurus* is so extraordinary that it might be regarded as ample ground for the establishment of a new genus, were it not for the close resemblances in other respects to certain other members of the genus *Nereis*.

Here we have an interesting problem. *N. cyclurus* and *N. fucata* are admittedly closely allied in some respects. The former inhabits the North Pacific, the latter the North Atlantic. It is probable that at a former epoch the distribution of the two was continuous (around the north coast either of Eurasia or of America, or *via* Panama). The existence of certain other closely allied and even identical species in the two regions points to this. Further, it seems probable that the hypothetical ancestor-species of the two had already formed its commensalistic habits before the distribution-area was severed (it would be a remarkable coincidence for the two allied species to have taken up the same habit independently—a habit not exhibited by any other nereid). Then, after the separation, the Pacific division of the ancestral species, apparently under the same conditions (both inhabit Gastropod shells tenanted by species of *Eupagurus*, *Pagurus*, etc.), has made an enormous stride in evolution, the while that the Atlantic division has remained more or less stationary!

NEREIS VEXILLOSA Grube.

Nereis vexillosa Grube, Ehlers (2), p. 573, Taf. xxiii. figs. 3–5.

An example of this fine species, labelled “St. Paul Island, Alaska, 1897,” accompanies the collection.

This form, originally described by Grube from the Sea of Okhotsk (3, p. 3, Taf. ii. figs. 1, 5, 6), is now known to inhabit also the west coast of America from Alaska to California. Izuka, in 1912 (5, p. 173), described a very closely allied species from Japan, *N. ezoensis*. He gives no reason for separating this, except that “the falcate end-piece of bristles [is] much longer in this species than in the closely allied *Nereis vexillosa*.” He figures a falcate bristle, but omits to state from what region of the body it is taken. Now, in *N. vexillosa*, as in certain other nereids, the length of the end-piece of the falcate bristles decreases very markedly, proceeding from head to tail. In the specimen before the writer at present, the falcigers from the posterior portion of the body have certainly appendages very much shorter than that figured by Izuka, but in those from the anterior portion (*e. g.*, 10th parapod) they are nearly as elongate as in the figure. I can discern no other difference between the two species from Izuka's description and his excellent figures, and would therefore suggest a more detailed comparison, with a view to determining the specific distinctions in a way more satisfactory to others. Apart from the progressive variation in length of the falcigers throughout the body of a single individual, that in different individuals must be taken into account.

NEREIS PELAGICA L.

Nereis pelagica L., Izuka (5), p. 154, pl. xvii. figs. 1–6.

One specimen, dredged near Turn Island, Friday Harbour, Puget Sound, 18th July, 1911.

This specimen is referred to in Mr. Potts' notes as a "blue nereid, among kelp-roots." It is a female heteronereid, of rather small size, measuring about 35 mm. in length, with 54 pairs of parapodia (the body is not quite complete posteriorly). The transition in the form of the parapodia occurs at nos. 16-17.

There is, I think, no doubt that this nereid is of the same species as that figured and described by Izuka (*loc. cit.*) under this name. But while it agrees exactly in other respects with Izuka's description and figures, it exhibits a difference in the paragnaths of the basal division of the proboscis (V-VIII groups). These are so numerous as to form a complete band around the proboscis, consisting chiefly of small, pale brown, rounded (not sharply pointed) paragnaths, covering closely almost the whole surface. Group VI is represented by a well-marked little bunch of large pointed paragnaths, which, if alone, would be almost exactly in accordance with Izuka's figure, but these are surrounded by the small paragnaths just described, which invade area V and also link the dorsal with the ventral areas. VII-VIII are affected in much the same way.

Izuka's figures do indicate that the paragnaths of the basal ring are more numerous than those of European *N. pelagica*, but I suspect that the present example must be a more extreme one, if not even an abnormality.

The proboscis was only partially everted, so that it would be difficult to figure it satisfactorily.

The modified parapodia agree in form exactly with those of the male heteronereid figured by McIntosh (8, pl. lxxi. fig. 7) and with those of other specimens from the British Isles.

NEREIS VIRENS Sars.

Nereis virens Sars, Grube (3), p. 6, Taf. i. figs. 2, 4, 5, 6.

N. brandti Malmgren (9), p. 183; Ehlers (2), p. 563.

N. dyamusi Izuka (5), p. 160, pl. xviii. figs. 1-12.

This large species was found in numbers in muddy beaches at Departure Bay, Pleasant Beach (Seattle), Barkley Sound, and Friday Harbour (*fide* collector's notes).

Two large examples are in the collection (locality?).

Nereis virens is well known on the west coast of North America, from California to Alaska, and was recorded from the Sea of Okhotsk by Grube in 1849. The Japanese representative has been named *N. dyamusi* by Izuka (see below).

Malmgren (9, p. 183) decided that the specimens from the Sea of Okhotsk represented a distinct species, which he named *N. brandti*. Ehlers (*loc. cit.*) followed him, but noted that the two species were so nearly allied "dass wir nur die Variation einer Grundform haben, welche circumpolar im Nordmeere verbreitet ist."

More recent workers, however, agree in considering the Pacific representative as identical with that of the Atlantic coasts [Johnson (6), p. 398; Moore (11), p. 344], and I follow these.

Moore, in 1909 (12, p. 244) "provisionally" bestowed the sub-specific name of *plenidentata* on specimens from California, which he found to be characterized by a larger number of segments and more numerous paragnaths. He also suggested that the form from the more northerly parts of the Pacific coast should be separated as *N. virens brandti*, on account of similar differences, which he found to be present in a less marked degree. His final opinion on the matter has not yet appeared.

Izuka (5, *loc. cit.*) finds his new species on slight differences in the numbers and arrangement of paragnaths in certain groups, and on the number of teeth in the jaws. I should like here to draw attention to an exceedingly good paper on *Nereis virens* from the Atlantic coast of America (17). In this the writer gives particulars of the variation of the paragnaths, which he found to be very wide even in a small number of specimens. I can see no reason for regarding the Japanese species as distinct from that of Western America.

NEREIS (PLATYNEREIS) AGASSIZI Ehlers.

Nereis agassizi Ehlers (2), p. 542, pl. xxiii. fig. 1.

Two small specimens from Departure Bay, 8th May, 1911.

These are both male heteronereids which were found amongst material dredged in the Bay.

The paragnaths have the arrangement typical of the species of the *Platynereis* group, I, II, and V being absent, the other groups represented by pectiniform rows, which are not so continuous as usual, but more broken up. (I have noted this feature occasionally in European specimens of *N. dumerilii*.)

The large homogomph falcigerous setæ of the notopodial bundle are represented by a single large bristle with fused appendage in each parapod, commencing about the 14th pair. These have been figured by various authors (2, 5, 10).

These two nereids, each of which has about 76 pairs of parapodia, are about 25–27 mm. in length. The heteronereid form is not completely assumed, many of the ordinary setæ not yet having been cast in the posterior region. In the more advanced of the two, the transition in the form of the parapodia occurs at the 19–20th pair. The noto-cirri of the first seven pairs have the characteristic swollen outline.

A considerable cloud hangs over the species of *Platynereis* which are found in the Northern Pacific (as in the case of those in other parts of the world).

We are concerned with the three species (?) :—

N. dumerilii Aud. et Edw.

N. kobiensis McIntosh.

N. agassizi Ehlers.

These species in the Pacific Ocean (*dumerilii*, of course, occurring elsewhere) are all characterized by the presence of

the curious fused falcigers in the notopodial bundle, figured by various authors and mentioned above. The presence of these setæ is the only valid point distinguishing any of these species from *N. dumerilii* of the Atlantic coasts which has hitherto been mentioned by any author. Further, no author has yet given any point of distinction between these three Pacific species which has the least weight whatsoever. For example, Izuka describes and figures them, one after the other, in his fine work on Japanese Polychæta, but gives no means whatsoever of distinguishing the three. They are apparently three absolutely indistinguishable species, and they even inhabit the same localities. Nor does he compare them in any way; in not one of the three fully detailed descriptions does he even mention the names of the other two species. Systematic zoology becomes impossible under these conditions.

It does appear that the *Platynereis* of the North Pacific in the adult form* is characterized by these peculiar fused falcigers (which there can scarcely be a doubt are fully homologous with the corresponding unfused homogomph falcigers occurring in *Platynereis* from all other parts of the Oceans).

If this is a valid specific distinction, then we have the following synonymy of *N. agassizi* Ehlers:—

- Nereis kobiensis* : McIntosh (7), p. 210, pl. xxxiv. figs. 3-6; pl. xvi A. figs. 2-4.
Treadwell (15), p. 226; (16), p. 1161.
Izuka (5), p. 162, pl. xvii. figs. 12-13.
Nereis dumerilii A. et E. : Izuka (5), p. 158, pl. xvii. figs. 7-8.
Marenzeller (10), p. 123, pl. ii. fig. 4.

Moore (11, p. 344) has already suggested "that the Japanese specimens referred to *N. dumerilii* by Marenzeller belong to this closely related but perfectly distinct species" (i. e., *N. agassizi*).

There remains, however, considerable doubt as to whether *N. agassizi* should not be regarded as a mere subspecies of *N. dumerilii*, and whether the latter has not a world-wide range in the Southern as well as the Northern Hemisphere. This I propose to discuss at a future date, after a more complete examination of the material from all parts of the world which is at my command.

MICRONEREIS VARIEGATA Claparède.

Micronereis variegata Claparède (1), p. 57, Taf. xi. figs. 5-7, 1863.

Four specimens, Departure Bay, May 1911.

* Von Marenzeller (10) figures an unfused homogomph falciger from a young Japanese example of *N. dumerilii*, which differs in no way from the ordinary type, and suggests that the unjointed type of bristle in old specimens is derived from this by fusion of the appendage in its socket.

I have compared these with specimens from the South of England, kindly lent by Major Elwes, and have been unable to find any points of specific difference between them.

Claparède's (*loc. cit.*) and McIntosh's (8, p. 261) descriptions and figures fit the British Columbia specimens as well as the European ones.

These tiny nereids, which range from about 4.5 to 7 mm. in length, were found inhabiting globular masses of mucus on brown *Ulva* dredged in Departure Bay. In one case the mucus contained a mass of eggs as well as the worm. On removal the mucus was again secreted. The general colour of the living animals was green, with transverse brown markings on the dorsum of each segment. The anal cirri were in one case dull crimson (Collector's notes).

One of the specimens exhibits a remarkable peculiarity, namely, the presence of a number of slender simple setæ interspersed among the ordinary compound spinigers. Whether these occur throughout the body I was unable to ascertain, but in the mid-region they are certainly present in several pairs of parapodia.

In the 10th, for example, we have the following:—

Notopodium: 15 spinigers, 17 simple setæ.

Neuropodium: 17 " 17 " "

The setæ are arranged in a single vertical series, the simple setæ appearing singly or two together between the compound. The former are from one-fourth to one-third the diameter of the latter, and from about one-third to nearly three-fourths the length; they are apparently perfectly smooth, and taper gradually to a fine point.

I have not found any trace of these in the other three specimens, so that it is not possible to regard their presence as a specific distinction.

It should be noted that the four specimens of *Micronereis* in this collection are of two different types—in this respect, that in two of them the trunk and especially the parapodia are so much swollen that adjacent parapodia are in contact with one another; while the remaining two have a scraggy, thin appearance, with wide intervals between adjacent parapodia. I am unable to account for this difference. The "fat" type is represented in text-fig. 2, while text-fig. 5 is of a parapodium of the other.

Micronereis has hitherto been recorded only from the French coasts, both Mediterranean and Atlantic (*Claparède, St. Joseph*), and from the South Coast of England (*Elwes*).

*Note on the Morphology of Micronereis, as a supposed
Representative of the Ancestral Type of the Nereidæ.*

In order to gain a satisfactory idea of the relationship of *Micronereis* to the rest of the family Nereidæ, a proper understanding of the external structure of the head and its appendages is, among other things, necessary. As these have not been very clearly or fully described by previous workers, I have taken some trouble to determine their relations in the Puget Sound specimens. Owing to the small size of the animals and the crowded condition of their appendages, this was a matter of some difficulty. Specimens were examined microscopically, both by reflected light and, after clearing, by transmitted light, and serial transverse sections of the anterior region of one were also cut with the microtome. The following description is based on an examination by these methods.

Text-figure 2.



Micronereis variegata, Puget Sound.

Anterior extremity from below, showing peristomial cirri and first five pairs of parapodia. $\times 45$.

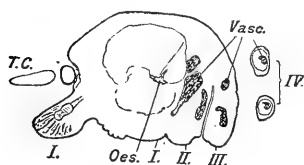
The first two setigerous segments bear parapodia consisting of one lobe only (text-fig. 2) corresponding to the neuropodium of the remaining feet. Anterior to these only one region is distinguishable, viz., the cephalic or peristomial region, which bears the two pairs of eyes on its dorsal surface. On each side this region bears also two rounded knobs or humps, anterior and posterior (the posterior being also situated rather higher on the side of the head than the anterior). Each of these four knobs bears two large subulate cirri, one dorsal, the other ventral.

The points of especial significance are:—

- (a) There is no trace of palps or tentacles.
- (b) No separate prostomial lobe, as distinct from the peristomium, is developed. The eyes are situated on the dorsal surface of the head in the same transverse plane as the peristomial cirri.

The above views differ from those of Claparède in several particulars. This authority considered that the first pair of parapodia was borne by the buccal segment, and that the first two pairs of parapodia represented the notopodia of the rest. As to the first point, I think it is plain, both in the case of Major Elwes' specimen and in the Puget Sound material, that the first pair of feet arises from the segment next behind that which bears the tentacular cirri. They are, however, directed forward in such a way that it is not unnatural that even a careful observer should conclude that they arose from the buccal segment, if one takes into account the minute size of the worm. The transverse sections make this point still clearer. As to the second point, the sections again show clearly that the first two pairs of feet bear cirri on the under surface—not on the dorsal, as would be the case if they were notopodia. Further, these feet plainly arise from the same level as the neuropodia of the following ones, as can be seen both in the sections and in the complete specimens.

Text-figure 3.



Text-figure 4.

Text-figure 3.—*Micronereis variegata*.

Transverse section (oblique) through anterior region, showing one of the posterior pair of tentacular cirri (T.C.) and their common base, and the first parapodium (I., on the left); on the right, I., II., III., IV. indicate the first four parapodia. Vasc., vascular tissue of same. $\times 56$.

Text-figure 4.—*Micronereis variegata*.

Oblique section through the 2nd parapodium, showing the ventral cirrus.
 \times about 137.

These points have an important bearing on the systematic position of the genus.

Claparède also suggested that the parapodial cirri were more of the nature of ligules ("Züngelchen") than true cirri, on account of their position and form. This view, however, seems to me to be quite unnecessary. The cirri have the position, size, and shape of true cirri, and in their cytological structure they also agree. (I have compared the sections with those of *Leptonereis* from Plymouth, which possesses typical nereid parapodia; the only cytological difference between the ligules and cirri in *Leptonereis* is in the presence of numerous blood-capillaries in the former, and their absence in the latter; otherwise they both consist of epithelial tissue and large glandular cells. The

parapodial cirri of *Micronereis* exhibit the same structure so far as can be seen from the material available, which was not preserved for cytological examination.)

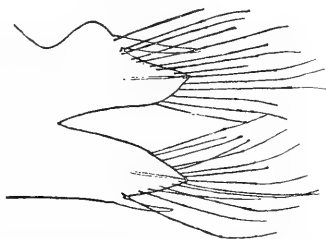
With regard to the four pairs of tentacular cirri, Claparède stated that he was unable to decide whether some of these should not be regarded as tentacles ("Kopf-fühler"). As has been indicated by McIntosh, these should probably all be regarded as cirri corresponding to the four pairs present in other nereids.

We are now in a position to compare *Micronereis* morphologically with other nereids. According to the above revised views as to the head-parts and parapodia, it would seem that we have in *Micronereis* a surviving descendant of the primitive ancestral type from which the successful nereid line of to-day has arisen.

The most characteristic features of this well-marked family are to be found in the peculiar, lobed, biramous parapodia, the well-developed prostomium or cephalic lobe with its palps and tentacles, the four pairs of peristomial cirri, and the armature of the proboscis with conical papillæ. All these features can be directly derived from the *Micronereis*-type. This I shall now endeavour to explain:—

Micronereis as a True Nereid.—The right of this genus to be included in the family Nereidæ is upheld by the following characters: the body-region bears on each segment a pair of deeply cleft biramous parapodia, each ramus supported by a

Text-figure 5.



Micronereis variegata. 10th parapodium, $\times 45$.

lance-like aciculum and giving rise to a series of compound homogomph spinigerous setæ of typical nereid form, and bearing a subulate cirrus on its external* surface. The first two pairs of parapodia are incomplete, the dorsal division (notopodium) with its spine and seta-bundle being entirely absent. Thirdly, the head-region bears dorsally two pairs of well-developed eyes situated at the angles of a trapezium, and

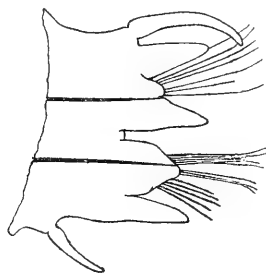
* *I. e.*, respectively dorsal and ventral in the noto- and neuro-podium.

laterally on each side two pairs of large tentacular cirri. Fourthly, the eversible proboscis is provided with a pair of curved toothed jaws.

Micronereis as a Primitive Nereid.—The primitive, undifferentiated condition of the genus is indicated by the following points: in the parapodia, the two rami consist of a simple setigerous lobe and cirrus alone, without the development of "lips" and ligules of the more advanced nereids. The occurrence in one of the Puget Sound specimens of simple setæ in addition to the compound spinigers may also be a primitive feature, as may the absence of falcigers. The prostomium and peristomium are fused*, or to put it in another way, *no distinct prostomial lobe has been differentiated from the buccal "segment,"* and, further, palps and tentacles have not begun to be acquired. Thirdly (and this I mention with some doubt, having had no opportunity of examining the everted proboscis), the proboscis is unprovided with papillæ, whether soft or hard.

Advances made by other Nereidæ.—The main ways in which other Nereidæ have progressed are in the differentiation of the parapodia, the arming of the proboscis with papillæ, usually cornified and hard, and the differentiation of a distinct prostomial or cephalic lobe, and the development of two pairs of sensory appendages (palps and tentacles) borne by this lobe.

Text-figure 6.



Parapodium from mid-region of *Nereis kerguelensis*, for comparison.
× 20.

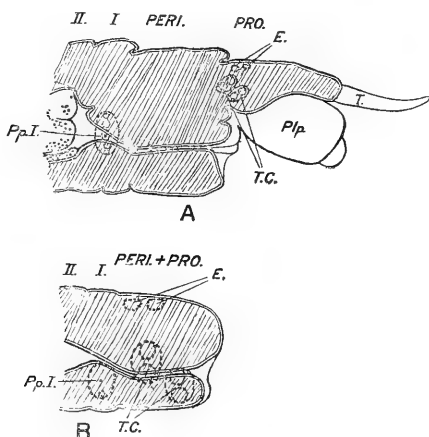
As to the parapodia, the more advanced type is easily to be derived from that of *Micronereis* by the gradual development and elaboration of subsidiary protuberances on the surface of the original simple setigerous ramus. The setigerous lobes of the typical parapodium will thus represent the apices of the original rami of the ancestral type, while the elongate ligules and the smaller "lips" are secondary developments from the sides of

* As Quatrefages has pointed out (14, p. 578).

the same. In *Dendronereis*, this lobation of the rami is carried still further (apart from the dendritic development of the cirri), while in *Ceratocephale* and *Tylorhynchus* the process has probably not gone so far.

Coming to the first two pairs of parapodia, we meet with a difficulty. In these, in the higher forms, the notopodium, although without the setigerous lobe with its spine and bristles, is nevertheless represented by a single ligule and a dorsal cirrus. Well, this is a difficulty, and for the present I shall leave it as such. I hope to elaborate this theory further in a larger work.

Text-figure 7.



A. Sagittal section of anterior region of *Nereis pelagica*, Plymouth.
× about 6.

B. *Micronereis variegata*. Sagittal section of anterior region.
(Diagrammatic.) × about 50.

PRO., prostomium; PERI., peristomium; I., II., first and second, setigerous segments; T., tentacle; Plp., palp; E., position of eyes; T.C., position of tentacular cirri; Pp.I., position of first parapodium.

The severed surfaces are indicated by shading.

And now we come to the prostomial lobe of the higher forms. This would seem to have been derived from the condition in *Micronereis* by the forward elongation and constricting off of the upper median surface of the head-region, in such a way that the eyes are carried forward so as to be included in the constricted-off lobe. Then on the anterior margin of this lobe palps and tentacles have been developed, in response to the need for more efficient sense-organs consequent on the enlarged activities and "wider outlook on life" which the higher Nereidæ have probably assumed.

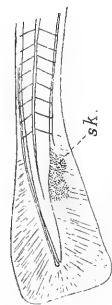
Text-fig. 7, A, B, will help to elucidate the foregoing explanation of the homologies of the cephalic region in the two types.

Conclusion.—According to the foregoing reasoning, *Micronereis* should be regarded as a more or less unaltered representative of a primitive ancestral form of the Nereidæ. It does not appear to me that the features of *Micronereis* can be regarded with as much probability as degenerations from the more highly developed type.

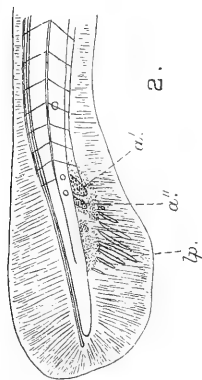
I have set forth these views of the facts with some diffidence, owing to my studies having been mainly confined to the single family, the Nereidæ. A wider knowledge of the nereidiform group of the Polychæta might perhaps produce an alteration of them.

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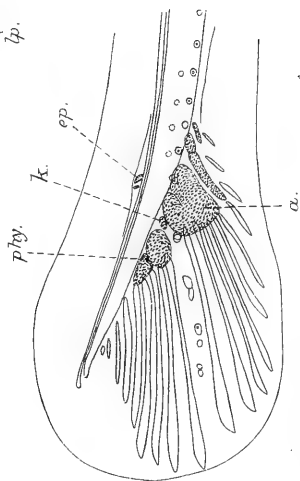
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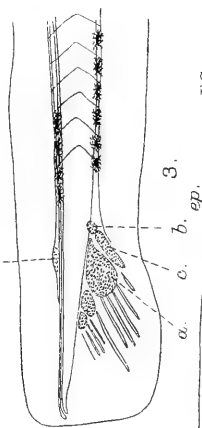
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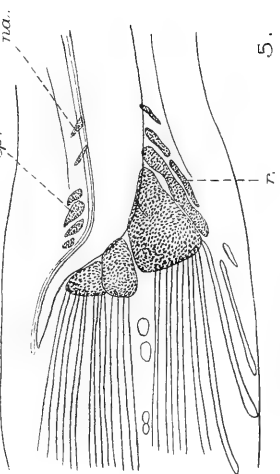
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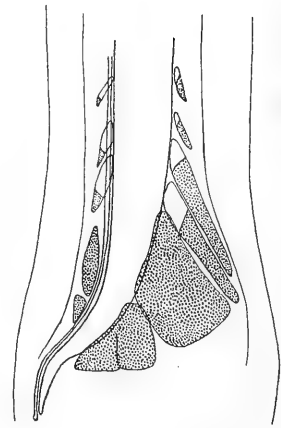
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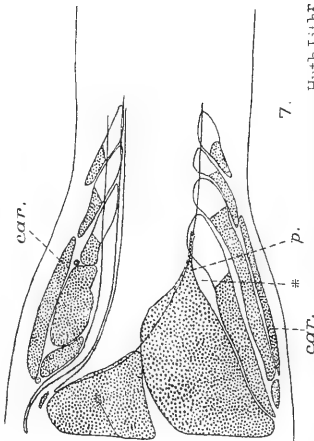
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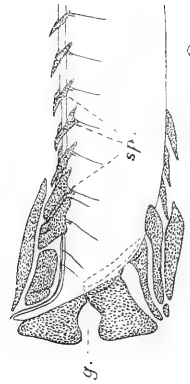


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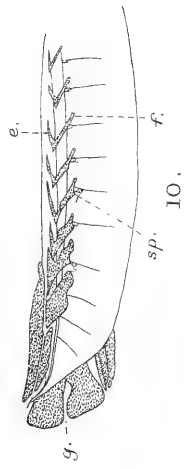
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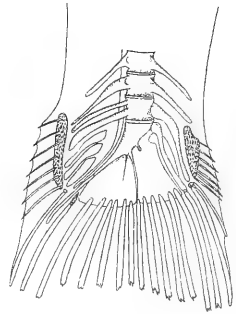
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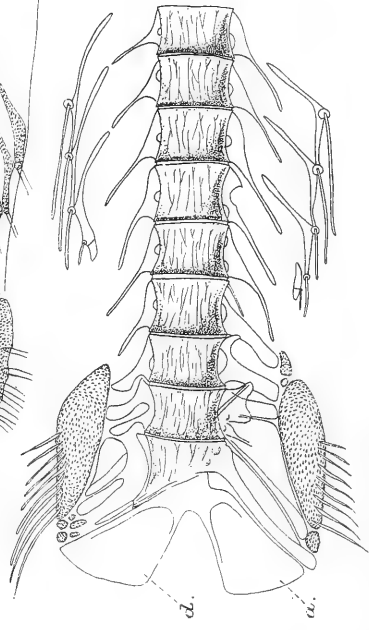
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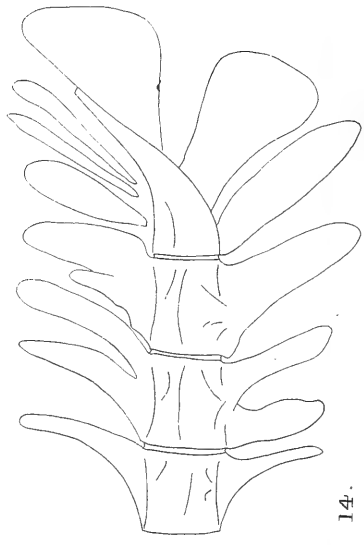
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CAUDAL SKELETON OF PLEURAGRAMMA ANTARCTICUM.

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16. The Structure and Development of the Caudal Skeleton of the Teleostean Fish, *Pleuragramma antarcticum*. By A. KNYVETT TOTTON*.

[Received December 17, 1913: Read March 17, 1914.]

(Plates I. & II.†)

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In this paper I have recorded several points of interest in connection with the development of the vertebral column of a Teleostean fish, *Pleuragramma antarcticum*. My material consisted of a collection of the post-larval stages collected on the Southern Cross Expedition, and handed over to the Imperial College of Science for description on behalf of the Trustees of the Natural History Museum by Professor Jeffrey Bell, to whom I here wish to express my thanks. To Professor E. W. MacBride, F.R.S., V.P.Z.S., at whose suggestion I undertook this piece of work, and under whose supervision it has taken its present form, and to Mr. H. G. Newth, for very much useful help, my thanks are due and are very gratefully tendered.

Unfortunately the *Pleuragramma* material does not contain stages quite late enough to show the actual formation of centra, though the largest specimens are about 4.5 cm. long.

I believe that no specimens of this fish have been taken intermediate in size between those at my disposal and certain specimens—adults 16–17 cm. long, taken from the stomachs of Seals,—one of which Mr. Tate Regan very kindly allowed me to examine, together with a specimen of *Trematomus newnesii*, a closely allied species in which the notochord is relatively smaller and the centra better ossified than in *Pleuragramma antarcticum*.

The fixative used in most cases appears to have been formalin or spirit, so that the material is not very good from a histological point of view.

Pleuragramma antarcticum is a specialised Teleost of the family Nototheniidae, the genus differing from the related Antarctic genus *Trematomus* chiefly in the feeble ossification of the skeleton. Boulenger included *Pleuragramma* in the family Leptoscopidae, but Regan has pointed out that it does not resemble *Leptoscopus*, but, on the other hand, is very near *Trematomus*. Most of the Nototheniiform fishes are littoral and feed on crustaceans, molluscs, etc. *Trematomus newnesii* and *Pleuragramma antarcticum* are amongst the more southern types, and appear to be circumpolar (cf. Regan, Trans. R. Soc. Edinburgh, xlix. 1913, pp. 251, 257, 264, &c.).

* Communicated by Prof. E. W. MACBRIDE, D.Sc., F.R.S., V.P.Z.S.

† For explanation of the Plates see p. 260.

The caudal skeleton of an adult specimen of *Pleuragramma antarcticum* consists of a number of relatively large cylindrical bony centra of a papery nature. To the terminal one are attached two expanded hypural bones, whose development proves that they are compound (*i. e.* that they represent more than two), and a third ventral hypural which is not so expanded. Between the latter and the ventralmost of the former two hypurals, the terminal branches of the caudal artery and vein come forth on each side in a notch. This terminal centrum bears no arches, but lying dorsal to it and the nerve-cord (not represented in Pl. II. fig. 12) are two bones, the epiural apophyses (*cf.* Huxley, Q. J. M. S. vol. vii. p. 41). Development shows that there were originally three, and there are even indications of a fourth. The penultimate centrum at first sight appears to be carrying two neural and two hæmal arches, but in the case of the neural arches, at any rate, development shows clearly that they have arisen through the division of one cartilaginous "Anlage."

I should like to make a digression here to discuss at greater length this phenomenon of a centrum bearing two neural or hæmal arches. I have collected a few cases from various authors, and have observed the phenomenon also in a few specimens in which it has not been described, so far as I am aware.

Mormyrus kannume has two hypurals on the penultimate centrum (*cf.* Whitehouse, "Caudal Fin of Teleostomi," P. Z. S. 1910, p. 596). I am not aware that the development of this fish is known. It would be interesting to see whether the adult condition was brought about by a division of a single cartilaginous "Anlage" or by a crowding together and displacement of arches, as is more probable.

Lotz (Zeitschr. f. wiss. Zool. Bd. xiv. 1864, p. 88) gives the following description of *Cottus gobio*:—"Der vorletzte Wirbel hat nur das Eigenthümliche, dass sein oberer Dorn sehr breit und oben gespalten ist, so dass er aus zwei verschmolzenen Dornen zu bestehen scheint." The figure shows a much expanded neural and a hæmal arch on the penultimate centrum, and the neural arch shows a line of division into two. I think this is a clear case of "division." Moreover, "division" seems to be connected in some way with expansion, as comparison with other cases will show. He says of *Barbus fluviatilis*:—"Der drittletzte Wirbel besitzt in der Regel zwei obere Bogen deren Dornen bereits als Stützen der kurzen Flossenstrahlen dienen, diess ist übrigens nicht constant; es kann auch nur ein oberer Bogen vorhanden sein oder es kann der vorletzte Wirbel deren zwei besitzen, während er in der Regel nur einen besitzt, dessen Dorn mit einem knorpeligen Ende versehen ist" (p. 86). On page 95 he says of *Salmo salar*:—"Am. 17-18. Tag. wird über dem Neural-canal hinter dem letzten normalen oberen Bogen (*g*) der erste falsche Dorn (*k*) gebildet." The "falschen Dornen" are the epiural apophyses. It is to be noted that the neural and hæmal arches have already been formed. Lotz continues: "Oft

der vordeste der falschen Dornen mit dem Dorn des letzten oberen Bogen verschmilzt oder es ist ein ganzer überzähliger Bogen vorhanden, so dass dann der viertletzte Wirbelkörper zwei obere Bogen erhält." The "Wirbelkörper" appear towards the end of the fourth month, doing so first in front.

O. Hertwig ('Entwickelungslehre der Wirbeltiere,' III. II. pp. 456-82), in the account of the development of the vertebral column of Teleosts by Schauinsland, says:—"Finally, it must be pointed out, too, that there are vertebræ in the tails of many Teleosts, with fully formed and equally developed double upper (or also both upper and lower) arches, the cartilaginous rudiment of which can sometimes even be shown." It is not very clear what he means by the last statement. Does he mean that there is a single "Anlage" or that there are two? He continues: "These vertebræ can be regarded either as corresponding to only two sklerotome halves, in which case, however, the arches belonging to each half have become exceptionally developed to an equal extent, or (which is more probable) as having arisen by the later union of the two complete vertebræ; that is to say, at least three, perhaps even four, sklerotome halves participate. In these cases, then, there would be real (secondary) "Diplospondyly." He does not bring forward any embryological evidence to prove his case, except the above-mentioned statement of doubtful meaning. He refers to a figure (270) of the "Dorsch" (*Gadus morrhua*) as showing double upper and lower arches on the penultimate centrum, but I believe there is something peculiar about the caudal fin-skeleton of *Gadus* which has not been described, with reference to these double-arch bearing centra. I understand that the appearance is due to partial fusion of arches and radials.

I myself have met with the phenomenon of a centrum bearing double arches in the case of *Trematomus newnesii*, where there are two very well-defined neural arches on the penultimate centrum (see Pl. II. fig. 13); also in the case of *T. borchgrevinki* (see fig. 14), where, curiously, it is the antepenultimate centrum which bears double upper arches and double hæmal arches as well. The penultimate centrum has greatly expanded arches, and, indeed, there is some slight indication of a division in the neural one, but the specimen was a dried skeleton and one not entirely free from flesh, so that I had some difficulty in making an accurate observation. In *Notothenia macrocephala* the arches of both antepenultimate and penultimate centra are somewhat more expanded than the rest, but only the penultimate neural arch shows any sign of division. I examined a number of allied forms, but did not come across any more cases of centra with double arches. I may mention that my drawings of the skeletons of the adult *Pleuragramma antarcticum*, and *Trematomus newnesii* were made from specimens dissected very carefully in spirit, and from which every particle of flesh had been removed, and as much connective tissue as possible also.

I will now return to my description of the caudal skeleton of *Pleuragramma antarcticum*.

One of the chief characteristics of this skeleton is the large size of the cartilages supporting the procurent rays. No doubt, this is connected with the weakness of general ossification. The caudal skeleton of an adult specimen of *Trematomus newnesii*, though generally similar to that of *Pleuragramma*, differs in several points. As mentioned above, the general ossification is much stronger. Correlated with this probably is the smaller relative size of the cartilages bearing the procurent rays. The epizural apophyses are three in number. The two terminal hypurals still retain something of their compound nature; finally, the penultimate centrum bears a well-defined double neural arch, but a single unexpanded hæmal arch. The free end of the notochord extends further, and that of the nerve-cord not so far as in *Pleuragramma*.

In specimens of *Pleuragramma antarcticum* of about 8 mm. (Pl. I. fig. 1), the tip of the tail and the notochord are bent slightly ventralwards, the angle thus formed being filled up by skleroblastic tissue (*sk*). This latter consists of mesenchymecells, in which the cytoplasm has become clearer and the nucleus more distinct (*i. e.* takes up stain more readily) than in the cells of the surrounding tissue. The continuous fin-fold round the tip of the notochord is expanded and supported by actinotrichia. Whether this bending down of the tip of the notochord is apparent in the living animals or not I do not know. It certainly appears in large numbers of fixed specimens. One is reminded, in connection with this, of the prolongation of the vertebral column into the lower lobe of the vertical caudal fin of the Ichthyosauria. I think the condition I have described can scarcely be due to fixation, because, since the skleroblastic tissue is denser than the tissue dorsal to it, the tendency of the fixative would be to shrink the upper tissue more than the lower, and so turn the tail upwards instead of downwards. I suggest that the presence of the skleroblastic mass under the notochord gives rise to some sort of stimulus causing this flexure. I should like to call attention to the fact that Ryder (U.S. Comm. of Fish & Fisheries, 1884, p. 1057), in describing the development of *Alosa*, says:—"Here the development of the hypurals is accompanied by a pressing inward of the ventral wall of the chorda." He gives a figure (fig. 2, pl. ii.) to illustrate his point. I think that the illustration would be more correctly interpreted as showing a ventral flexure of the chorda, since the dorsal wall of it is also involved.

In the next stage (.85 cm.) (fig. 2), the skleroblastic cells in the concavity of the notochordal flexure have become divided into an anterior and a posterior mass, and a hyaline matrix has been secreted around and between certain of them, and in this way three blocks of cartilage are formed, two in the anterior mass of skleroblastic tissue and one in the posterior mass. Lepido-

trichia (*lp.*) have also been formed at the margin of these blocks of cartilage.

Stage III (1.05 cm.) (fig. 3).—Darkly staining skleroblastic tissue (*sk'*.) has now made its appearance above the notochord immediately dorsal to what will later become the "ventral hypural" (*a.*). It is significant to note that just at this time the notochord is becoming straight again. This secondary dorsal flexure is started, I suggest, by some stimulus due to the appearance of this new mass of skleroblastic tissue. More cartilage has now been formed ventrally, in front of the two pieces already described (Stage II), in the anterior skleroblastic mass, which two pieces have probably fused to form *a*, fig. 3. This new cartilage consists of a pair of proximal pieces and a median distal piece. The former, *b*, represent a hæmal arch and the latter is a radial. That the proximal pair of cartilages represent, or are serially homologous with, the arches which appear later and more anteriorly seems probable, because they correspond well enough in size and in the manner of their appearance. I must confess that I am not quite satisfied that the proximal and distal parts are actually separated, as the appearance of the line of separation may be due to optical section. In any case, the fusion between arch and radial in the next anterior segment is quite clearly seen (figs. 5 & 6), so that the evidence for the fusion of the above-mentioned elements is presumptive.

One may regard these cartilages, perhaps, as being in a condition intermediate between that of the hypural behind, which apparently is formed from the skleroblastic tissue as fused arch and radial, and the condition of the arch in front, where fusion of the originally separate elements can be seen as development goes on. I may say here that the term "hypural" is limited to those pieces of cartilage (which may later become ossified) which represent or are actually made up of fused arches and radials. The hypural (*a*, fig. 3), behind the one whose development I have just traced, is a good deal larger than this latter, and is somewhat rounded when seen laterally. It is beginning to form an anterior peg which later on passes through the arch formed by the proximal end of the hypural next in front, and lies just dorsal to the caudal artery and vein which run in the arch. The caudal fin is now beginning to be constricted off ventrally from the median fin-fold.

Stage IV (fig. 4).—Examination of specimens 1.3 cm. long shows that the upturning of the notochord has gone on further, and produced from the straight condition seen in the specimens 1.05 cm. long one in which there is a distinct dorsal flexure. The epaxial elements (*ep.*), formed by the skleroblastic tissue mentioned in the last stage, lie in the concavity thus formed. The posterior hypural cartilaginous block (*phy.*) can now be seen to be made up of two partially-fused blocks, or, rather, the original mass of skleroblasts has secreted two masses of matrix, which are not completely divided the one from the other. Similarly, the hypural

in front (*a.*) is incompletely divided into two on the proximal side, showing that it represents more than one hypural. There is, in the specimen figured, a small piece of cartilage (*h.*) between the "posterior" and "anterior" hypurals. This would appear to be exceptional, and may be the vestige of another hypural. Hæmal arches are now beginning to appear anterior to the hypurals, developing from behind forwards. The matrix secreted by the skleroblasts diminishes in amount as one goes forward. The lepidotrichia are still better developed and extend to the margin of the fin. There is figured a row of lateral-line sense-organs on each side, which extends on to the future mid-line of the caudal fin, dividing the lepidotrichia into a dorsal and a ventral series.

Stage V (1.55 cm.) (Pl. I. fig. 5).—There are now three distinct (a rudimentary fourth) epaxial elements (whose appearance seemed to give the signal for the secondary flexure of the notochord). In transverse section they show no signs of forking at their proximal ends, and they originate from single median masses of cartilage, not from paired pieces as do the arches. They are much closer together than the neural arches, which are now appearing anterior to them, much in the same way as the hæmal arches arose. There is a gap between these epaxial elements and the neural arches. These elements, moreover, stand quite clear of the nerve-cord, not arching it over as the neural arches do. They probably correspond to Huxley's epidual apophyses in *Gasterosteus* (Huxley, Q. J. M. S. vol. vii. p. 41). The fusion between the neural arch and radial, described as possibly existing in Stage III, is now complete: there is no line of division between the matrix of one and that of the other. A slight notch has appeared in the posterior border, and it is here that the caudal artery and vein run out on either side. A radial (*r.*) at the distal end of the hæmal arch next anterior to the one just described has been formed at this stage, but no fusion of the two elements has yet taken place.

In Stage VI (1.8 cm.) (fig. 6) there is still no sign of the cartilages to which the procurent caudal fin-rays are attached in the adult. A typical neural arch, taken further forward than those shown in fig. 6, extends at this stage through a length of about 136 μ . It consists of a pair of cartilages lateral to the nerve-cord. Their bases do not reach the notochord, and their thickness in transverse section is about 8 μ . The hæmal arches also consist of pairs of cartilages which do not reach up to the notochord. They are each about 16 μ thick, and are separated at their distal ends by about 16 μ of closely packed skleroblastic cells, which have not secreted any matrix as yet. Further forward the cartilages are considerably smaller, restricted to the sides of the caudal vein, and extend only through a length of about 30 μ . Posteriorly the skleroblasts between the distal ends of both dorsal and ventral pairs of cartilages have secreted a matrix, and in this way the pairs of cartilages have become

fused. Their proximal ends have grown till they now stand on the notochord.

The hypurals are now beginning to expand laterally at their proximal ends, so as to form a broad seat for the convexity of the upturned notochord, so that the thrust of the tail is more widely distributed. Fusion has taken place between the hæmal arch and radial (*r.*) described in Stage V. The epaxial elements behind the neural arches have undergone a certain amount of fusion, so that there is now a smaller posterior and a larger anterior cartilage. The caudal artery and vein are both forked at their posterior ends to pass round the large "ventral hypural," which is not arched, to admit of their passage between it and the notochord. Fig. 6 is a reconstruction of this stage from a series of transverse sections.

Stage VII (2.2 cm.) (fig. 7).—Long narrow cartilaginous pieces (*car.*) have now made their appearance, one dorsally to the two posterior neural arches and the three original (apparently now two) epiural apophyses described above, and another ventral to the most anterior hæmal arch. They give articulation to a dorsal and a ventral group of procurent lepidotrichia. From the shape and position of this ventral piece of cartilage, it appears possible that it may be the homologue of the two radials or hypural apophyses which appeared just behind it and underwent fusion with two hæmal arches. The anterior ends of both these new cartilages develop into two or three smaller and more or less separate cartilages. The anterior peg of the "ventral hypural" now extends between the proximal ends of the next anterior hypural, with which it eventually fuses, giving rise to the appearance in transverse section of a fusion of the halves of the arch themselves, and making in fact a small bridge, dorsal to the caudal artery and vein, which has rather a puzzling appearance.

The division between the halves of the "dorsal hypural" (*d.*, Pl. II. fig. 8) has now disappeared, or, in other words, the two uppermost hypurals have fused (Stage VIII), and a certain amount of absorption of the two large hypurals seems to be taking place, which, together with growths in other points, such as the posterior margins and the proximal ends, causes a considerable change in shape. Between Stages II and VII the rate of growth of the hypurals is greater than the rate of increase in girth of the notochord; but between Stages VII and X there is a reversal of this disparity which culminates in the condition where the notochord has the relatively enormous proportions so characteristic of the latest available postlarval stages of this fish. Stage VIII shows the first step in this inflation of the notochord, but here, as in later stages, the upturned tip or Chordastab is not affected. In this respect Teleosts show an important difference from Elasmobranchs (see Schauinsland, p. 462). Figs. 9 and 10 are drawn under the binoculars with camera lucida, and show a dissection of the posterior end of the notochord, nerve-cord, and cartilaginous elements of a fish 4.2 cm. long.

Fig. 9 is practically a lateral view and fig. 10 a dorso-lateral view. It will be seen that the posterior neural arches are much further developed than the anterior ones.

Reference to the adult fish (fig. 12) shows that the neural arch has, on each side, two points of attachment to the centrum, between which points the segmental nerve emerges. Examination of Stage IX proves that the primary point of attachment is the anterior one; the process of formation of the posterior one—as a backwardly directed spur (*sp.*)—can be seen in figs. 9 and 10. A comparison of these backwardly directed spurs with some cartilages described by Schauinsland in Hertwig's book (p. 467) shows that it is probable that they represent intercalaria.

Schauinsland says: "The bulk of the base of the arch (cartilaginous stage) is at the cranial end of the vertebra, but this base sometimes extends caudalwards (Pike). The caudal part may even be cut off to form a separate piece of cartilage (*e. g.* in the tail of the Trout). This," he considers, "should be looked upon, probably in the case of the Pike and pretty certainly in that of the Trout, as the remnant of the second arch and as homologous to the cranial arch of *Amia*" (*i. e.* it is formed by the cranial half of a sklerotome: for this reason it is on the caudal end of a vertebra).

Stage X.—The posterior edges of the three large hypurals (fig. 11, 4.5 cm.) have grown considerably, owing to additions from the large enveloping cap of skleroblasts (not shown in figure) on which the lepidotrichia are seated. The proximal ends of these hypurals have grown also with the notochord, so that a large gap (*g.* figs. 9–11) has appeared—and continually increases in size—between the dorsal and ventral hypurals. It will be noticed that the posterior neural arch is dividing into two.

The adult specimen I dissected was 16.5 cm. long. The centra are very "papery," and constrict the notochord only very slightly. The condition of the posterior neural arch is interesting. At first sight the penultimate centrum appears to be carrying two arches. Comparison with previous stages, however, shows that this is not so, but that the appearance is due to the fact that the division, incipient in Stage X, has now been completed. As a result of this, the segmental nerve, which in Stage IX emerged beneath the undivided arch, now lies in the cleft, and a secondary ossification *beneath* the nerve has finally reunited the two half-arches at their points of attachment to the centrum. Similarly, the hypural carried by this centrum has divided, and the two halves are covered by confusing secondary ossifications.

The double neural arch in *Pleuragramma antarcticum* and the arch immediately in front of it are considerably more expanded and better ossified than those in front of them.

The posterior part of the hypural borne on the penultimate centrum of *Pleuragramma antarcticum* has a thick, well-ossified, posterior edge, especially thick at the tip, while the rest of it is very thin and membranous. The hypural behind the one just

mentioned has similarly a thick, well-ossified, posterior edge and proximal portion, whilst the rest is very thin and membranous. The dorsal and ventral hypurals, which give attachment to the majority of lepidotrichia, are now widely divergent, thin, and membranous. These two, together with the hypural immediately in front, are ankylosed to the last centrum. Of the two epiurals whose development I have traced above, the posterior one is well ossified and thick, while the anterior one has a thick, well-ossified posterior edge and a thin, membranous, expanded anterior edge. The upturned tip of the notochord is quite free and naked, reaching about halfway up to the anterior margin of the dorsal hypural (*d.*). The upturned nerve-cord also runs up to about this level, beyond which I have failed to trace it in the dissection I have made. The cartilaginous elements to which the fin-rays are attached have grown a good deal by this time, but have not become ossified.

SUMMARY.

1. The development of the vertebral column begins at the caudal end, the hypaxial elements being the first to appear. This coincides with a down-bending of the notochord (compare with this the analogous condition of the vertebral column in the Ichthyosauria). Epaxial elements do not appear until this condition has given way to the straight condition again. Arches appear as paired cartilages at the sides of the caudal artery and vein and of the nerve-cord. They are separated from the notochord by connective tissue.

2. The notochord is of a relatively enormous size, and persists with only slight constriction throughout life. The centra consist of thin papery lamellæ of membrane-bone. Ossification is generally weak.

3. The neural and hæmal arches of the penultimate centrum are double, owing to the splitting of single rudiments. Similar phenomena are to be observed in other fishes. They may be produced by different causes:—

- (1) Splitting of an originally single rudiment.
- (2) Crowding of two arches on to one centrum.
- (3) Fusion of the first epiural apophysis with the last neural arch.
- (4) Exceptional equal development of both arch and intercalary.
- (5) Secondary diplospondyly, *i. e.* fusion of two centra.

4. Large cartilages are present above and below the last two centra in the adult, which support a dorsal and a ventral series of procurrent fin-rays. Their great size is probably connected with the weakness of general ossification.

5. The hypural bones of the adult are formed by a fusion of hæmal arches and radials. This compound nature of the hypurals

may be seen anteriorly in adult Selachians and in the Sturgeon, but it has not been shown before, as far as I am aware, in Teleosts.

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EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. Tail end of a specimen of *Pleurogramma antarcticum*, 8 mm. long. The specimen was stained, cleaned, and mounted whole in Canada balsam. The skleroblastic tissue, *sk*, is represented semidiagrammatically by dots. Notice the down-bending of the tip of the notochord.
2. Tail end of a specimen of *P. antarcticum*, '85 cm. long. Camera-lucida sketch from a whole mount. Notice down-bending of the tip of the notochord, the formation of definite cartilaginous elements, *a'*, *a''*, by the skleroblastic tissue, and the appearance of lepidotrichia, *lp*.

- Fig. 3. Camera-lucida sketch of the tail of a specimen of *P. antarcticum*, 1.05 cm. long. Notice the appearance of skleroblastic tissue, *sk'*, dorsal to the notochord, accompanied by a slight up-bending of the tip of the notochord. *a*, a fusion of cartilages marked *a'* and *a''* in fig. 2. *b*, a hæmal arch. *c*, a radial.
4. Tail of a specimen of *P. antarcticum*, 1.3 cm. long. Definite cartilaginous elements, *ep*, have been formed dorsal to the notochord, which has now a marked dorsal flexure. Notice the row of lateral-line sense-organs extending on each side along the trunk and on to the dorsal fin, marking its future mid-line. *phy*, posterior hypural. *k*, an abnormal piece of cartilage.
 5. A whole mount of the tail of a specimen of *P. antarcticum*, 1.55 cm. long. The dorsal flexure of the notochord has reached its maximum. Neural arches, *na*, have begun to appear. The figure shows three stages in the formation of a hypural. Anteriorly there is a hæmal arch, behind it is another hæmal arch with a radial, *r*, at its distal end. The two elements have not begun to fuse. Behind these again is a hypural (for description of which see Stage III).
 6. A reconstruction from a series of sections of the tail of a specimen of *P. antarcticum*, 1.8 cm. long. (Sections posterior to "dorsal hypural" lost. Tip of notochord and nerve-cord hypothetical.) The cartilaginous elements are represented as seen in a section near the sagittal plane. Notice the fusion that has taken place between radial and hæmal arch seen in fig. 5.
 7. A reconstruction from a series of sections of the tail of a specimen of *P. antarcticum* 2.2 cm. long. Notice the anterior peg, *p*, of the "ventral hypural" which passes between the notochord and caudal vein and artery, fusing with the proximal portion of the hypural in front of it. Notice also the cartilaginous elements, *car*, which later on give attachment to the anterior dorsal and ventral procurrent fin-rays. An asterisk marks the exit of the caudal artery and vein from the hæmal arches.

PLATE II.

- Fig. 8. A dissection of an "odd tail" of *Pleuragramma antarcticum*, probably 2.8 cm. long. It shows the uniform nature of the "dorsal hypural," *d*, (the compound nature of which has been seen in previous figures). It will be noticed that the posterior neural arch, *n*, is expanding at its distal extremity.
9. An antero-lateral view of a dissection of the notochord and cartilaginous elements of the posterior end of a specimen of *P. antarcticum*, 4.2 cm. long. It was drawn under Zeiss binoculars with the aid of a camera lucida. Note the increase in development of the neural arches from before backwards. The sketch illustrates the way in which the neural arches grow over the segmental nerves. *sp*, backward growing spurs. *g*, gap between dorsal and ventral hypurals.
 10. A latero-dorsal view of the specimen figured above (fig. 9). It will give a better idea of the shape of the neural arches. *e, f*, the two halves of a neural arch.
 11. A camera-lucida sketch of a dissection (mounted in balsam) of the notochord and cartilaginous elements of the posterior end of a specimen of *P. antarcticum* 4.5 cm. long. Notice the incipient division of the posterior neural arch into two. A considerable change in the shape of the two large hypurals has taken place (see text, p. 257).
 12. A dissection of an adult specimen (16.5 cm.) of *Pleuragramma antarcticum*. The tip of the notochord is represented as being naked. The attachment of the large hypurals is rather broken in this specimen (it had been devoured by a Seal), so that it is quite possible that the tip of the notochord was ensheathed by thin membranous bone. The drawing was made with the help of a camera lucida and Zeiss binoculars. *d*, posterior or dorsal hypural. *a*, anterior or ventral hypural.
 13. A dissection of a specimen of *Trematomus newnesii*, 6 cm. long (adult?). It is given for comparison with fig. 12. The tip of the notochord is naked and extends out between the caudal fin-rays.
 14. A diagram of the caudal skeleton of *Trematomus borchgrevinkii*.

17. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.

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(Text-figures 1-8.)

XIII. ON TWO NEW SPECIES BELONGING TO THE GENERA *OCHORISTICA* AND *LINSTOWIA*, WITH REMARKS UPON THOSE GENERA.

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The material upon which the following observations are based was collected at the Society's Gardens during September and October of last year, and suitably preserved for microscopical examination. I was only able to make observations upon the living worm in the case of *Oochoristica marmosæ*. Both worms were parasitic in the small intestine of their host.

§ *LINSTOWIA AMEIVÆ*, sp. n.

I have examined three examples of a Cestode from the Surinam Lizard, *Ameiva surinamensis*, which I place—at any rate, for the present—in the genus *Linstowia*; for I shall call attention on a subsequent page (p. 281) to the difficulty of distinguishing *Linstowia* and *Oochoristica* as they have been defined up to the present time.

The worm is a small one, measuring up to 25 mm. in length with a diameter (where it is broadest) of 1.5 mm. There is no rostellum and the four suckers are unarmed. The scolex (when the worm, at any rate, is in a state of contraction) is not wider than the body which follows; the latter gradually increases in diameter. A neck is present in which no segmentation occurs; the rudiments of the generative organs appear almost coincidentally with the commencement of segmentation. The only other external character to be noted is the alternation of the genital apertures, which are always anterior in position in the segment. In transverse sections the cortical layer is seen to be thick, its diameter in both dorsal and ventral layers being fully as great as that of the entire medullary layer in the same section. This is one of the reasons which lead me to refer the present species to the genus *Linstowia* as commonly defined.

Such sections also show the disposal of the longitudinal muscle-fibres into bundles. As will be seen from text-fig. 4 (p. 270) there is only one row of bundles, which is by no means so marked as is that in two other species belonging to the same genus or to

Oochoristica, and which are represented in the same figure for the purpose of a readier comparison. In *Linstowia ameiva* the bundles contain a varying number of fibres—from as few as two or even one up to nine or ten. Midway between this inner longitudinal layer and the subcuticula is an outer layer of longitudinal fibres, which are largely implanted singly or in twos, and everywhere form a much thinner layer than the inner row.

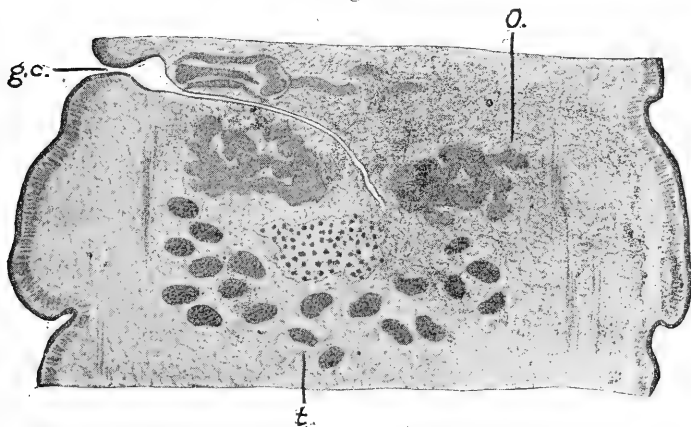
The *water-vascular system* is like that of other species of *Linstowia*; but it is not always quite easy to interpret the facts. In transverse sections I have seen the smaller dorsal vessel lying above the ventral either directly or more obliquely; and this in quite neighbouring sections, in others of which the two vessels lay side by side, the dorsal outermost, *i.e.* nearer to the nerve-cord. This is evidently due to the varying degree of contraction of the proglottids, a fact also emphasized by the zigzag course of the vessels when viewed in horizontal sections. I believe that the normal position of these vessels is side by side. The inner and larger of the two tubes, which I regard as the ventral vessel, gives off several branches in each segment, which are themselves branched. There also appear to be connections between the ventral and dorsal vessels. I cannot, however, give a map of this network.

The *testes* lie posteriorly to the vitelline gland, and reach forward on either side of it; they do not, however, extend laterally of the ovary. In a given segment the testes were visible in 18 consecutive sections. The largest number counted in the middle of the series was 43. I therefore calculate the total number to be about 200. The testes do not extend laterally beyond the lateral water-vascular vessels.

The *genital ducts* of this tapeworm open on to the exterior, as already mentioned, alternately, with, however, no absolute regularity in the alternation. They both open—the cirrus-sac in front of the vagina—into a *genital cloaca*, whose external pore is close to the anterior margin of the proglottid. This genital cloaca is separated into two regions, which are obviously of different morphological value. Outside is a funnel-shaped chamber, the apex of the funnel lying to the inside. In longitudinal sections through the cirrus-sac it was occasionally noted that the bottom of the funnel was almost completely closed, leaving but a narrow slit of communication with the inner chamber of the genital cloaca. The latter is roughly spherical in form, and receives the openings of the cirrus-sac and the vagina. Its depth is not very different from that of the outer funnel-shaped region. In longitudinal sections, it is seen to be marked off from the outer chamber by a projection on either side which is the expression in such a section of a circular fold. This fold is muscular and a thick layer of muscles, of which it is a part, encircles the whole of the spherical chamber of the genital cloaca. The *cirrus-sac* lies in the same straight line with the genital cloaca, and is thus at right angles with the long axis of the body of the worm. The cirrus-

sac is somewhat hourglass-shaped through being compressed in the middle; but the anterior end, *i. e.* that nearest the exterior of the body, is not so wide as the posterior end. The cirrus-sac has a thick muscular coat, which thins out only posteriorly; this end of the cirrus is thin-walled and globular in shape. The cirrus-sac of this *Linstowia* is large, but not so large as in *L. echidnæ* and *L. semoni*. In the ripe segments the total length of the cirrus-sac and the genital cloaca is between $\frac{1}{4}$ and $\frac{1}{5}$ of the body diameter; more anteriorly, where the cirrus-sac is not fully formed, but still differentiated from the sperm-duct, and where the body is narrower, the length is between $\frac{1}{4}$ and $\frac{1}{5}$ of the diameter of the proglottid. The end of the cirrus-sac lies considerably to the inside of the nerve-cord; it reaches the level of the innermost of the longitudinal water-vascular trunks.

Text-figure 1.

*Linstowia ameivæ*.

Horizontal section of a proglottid in which the uterine cavities are not yet developed.

g.c. Genital cloaca. *O.* Ovary between which and testes, *t.* lies vitelline gland, not lettered.

I note, finally, that the lateral nerve-cord, where it is crossed by the cirrus-sac, is bent outwards for a space. Soon after issuing from the cirrus-sac the *sperm-duct*, at first only sinuous, forms a coil; this region of the vas deferens is surrounded by laxer parenchymal tissue than that which pervades the body generally, but which presents no glandular characters.

The *vitelline gland* of this species presents the usual characters. It lies at about the middle of the proglottid antero-posteriorly, as well as from side to side. It is smaller in horizontal diameter than the ovary, which lies in front of it, or than the mass of

testes, which lies behind it. The vitelline gland is not in contact with the ovary, and between them lies the shell-gland. In a complete series of horizontal sections, it can be observed that the vitelline gland extends further ventrally than any of the gonads and that it nearly reaches the dorsal limits of the medulla. The duct of this gland is comparatively wide where it leaves it anteriorly, but soon narrows. The vitelline gland is later in its growth than the ovary, for, in earlier proglottids than such as are referred to in the above description, the vitelline gland is proportionately considerably smaller than the ovary.

The *ovary* is single and as nearly as possible in the middle of the body. It is, as is so usual, mainly developed laterally in two wings. The ovary lies in front of the vitelline gland and of the testes; it is very near to the anterior border of the proglottid. The ovary, as is usual, is not solid and compact, but frayed out laterally in a digitiform fashion. The ovary extends laterally beyond the vitelline glands, but not so far as do the testes.

The *female efferent apparatus* is simpler than in many tape-worms. It opens into the genital cloaca by an expanded funnel-shaped mouth lying behind the entry of the cirrus-sac. The vagina runs a straight course to about the middle of the proglottid, where it bends posteriorly and becomes coiled before opening into the shell-gland. There is no dilatation along its course—nothing that can be described as a receptaculum seminis. Even in quite ripe proglottids there is no change in the female duct, except a slight diminution of the always narrow lumen.

§ *Uterus and Embryos.*

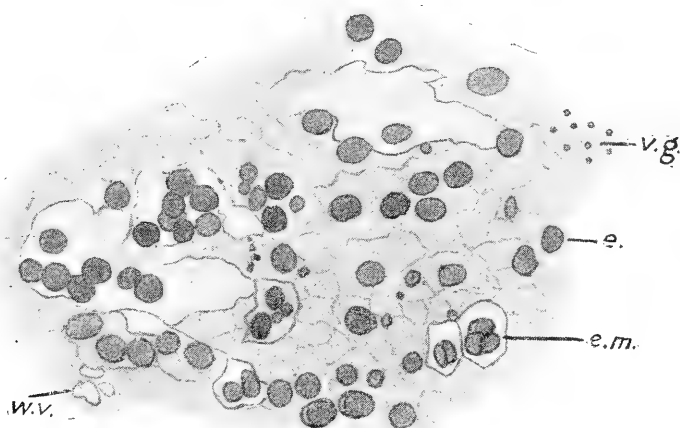
In this species, as in others referred to the genera *Linstowia* and *Oochoristica*, a uterus exists for a space; but later the embryos come to be implanted singly in the parenchyma of the body.

One remarkable feature of the uterus in this species is its sudden appearance. In one proglottid there is no trace that I could discover of a uterus. In the immediately following proglottid the uterus was present in a well-developed condition. Its general appearance under a low power is shown in text-fig. 2. The ripe ova (*ova* at this stage, not embryos) are found over a large area of the proglottid, but limited to the medullary region: indeed, they do not extend outside of the lateral trunks of the water-vascular system. These scattered ova are found in front of the ovary as well as behind it; they also occur among the testes, where the latter begin to thin out ventrally. They are thus mainly ventral in position, the testes being mainly dorsal.

Although the cavities lodging the ova have, so far, been spoken of inferentially as a uterus, there is no continuous uterus in this worm with its own definite walls. On a rapid glance at such a section as that which is represented in text-fig. 2, the impression given may be that the ova are contained in a series of circular or

oval spaces which intercommunicate. A more careful examination, however, under higher powers, does not entirely confirm such an impression. There are undoubtedly cavities of varying dimensions in which one or more eggs often lie; these cavities are, to some extent, of irregular shapes, and their prolongations may anastomose. But there is no doubt that there are cavities containing eggs which are entirely isolated from the others. There is, in fact, nothing that can be described as a branched or retiform uterus with a continuous cavity. And it is to be observed that I am here speaking of the earliest proglottids in which the uterus occurs—not of later segments where it might have been broken up into detached cavities. Moreover, a nearer inspection of some

Text-figure 2.



Linstowia ameivæ.

Portion of a section through a ripe proglottid showing disposition of ova.

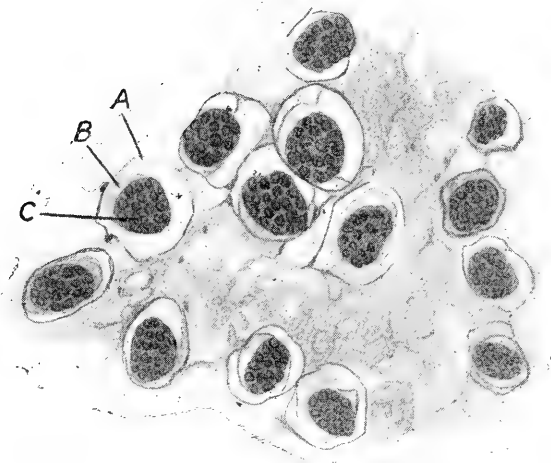
e. Ova lying in parenchyma. *e.m.* Ova lying in definite uterine spaces.
v.g. Remains of vitelline gland. *w.v.* Water-vascular tubes.

of the egg-containing cavities shows that they are traversed by delicate strands of tissue—that, in fact, they are not really all of them cavities, but are merely looser regions of the delicate network which chiefly constitutes the medullary parenchyma. Furthermore, plenty of eggs are placed singly between the meshes of the parenchyma enclosed in no special cavities and even lying just outside of such cavities as have been described above. Some of these eggs have already formed embryos; but perhaps the majority are still in the unicellular condition. These eggs, whether lying singly in the parenchyma or a few together in cavities, extend over much of the proglottid and are quite in

contact with the anteriorly situated ovary. It is impossible to say where ovary ends and "uterus" begins. There is nothing in these facts to forbid the assumption that the eggs leave the ovary and migrate directly into the parenchyma, not reaching it *via* a uterus.

Towards the end of the body the uterine cavities, if they be such, have completely disappeared, and the embryos (text-fig. 3) are more or less evenly scattered through the parenchyma. They even get to be found in the cortical parenchyma, though by no means numerous. It is not infrequent among tapeworms for

Text-figure 3.



Linstowia ameiva.

Portion of a section through a more fully ripe proglottid than that represented in text-fig. 2, and also more highly magnified.

- A. Outermost membrane of the embryo. B. Middle membrane.
C. Embryo surrounded by delicate innermost membranes.

the ripe embryos to lie also in the cortical parenchyma; and in an ally of the present species, viz. *Linstowia brasiliensis*, the eggs stray thither*. The ripe embryos of the present species are hexacanth, as is usual; each appears to be wrapped in three shells—unless the outermost membrane, which is more stainable by hæmatoxylin, be regarded as belonging to the maternal tissues. The spaces of the parenchyma, in one of which each embryo lies, fit the shells fairly accurately, and show no signs of being independent cavities lined by an epithelium.

* v. Janicki, Zeitschr. wiss. Zool. lxxxi. 1906, Taf. xx. fig. 2.

The principal features in the anatomy of this worm may be thus summed up :—

Linstowia ameivæ, sp. n.

Length up to 25 mm.; greatest diameter 1.5 mm. Rostellum absent; four suckers unarmed. A neck present; posterior segments increased in length, but not longer than wide. Genital pores alternate in position, close to anterior margin of segment. Cortical layer thick, about the same diameter as medullary layer; longitudinal muscles in two layers, innermost of small bundles of fibres not more than 8 or 10 to a bundle, and often less, outermost layers of fibres implanted singly or in twos. Water-vascular tubes lie side by side, the smaller dorsal tube being external; there is also a network of excretory tubes. The testes lie posteriorly to the ovary and vitelline gland, and extend to the dorsal surface, but do not overlap female gonads; cirrus-sac moderately large with muscular walls opening into genital cloaca in front of vagina, cirrus without spines; sperm-duct coiled, without vesicula seminalis. Ovary single with lateral wings, lying in front of segment. Vitelline gland, not so extensive, lies behind. Vagina without dilated receptaculum seminis. Eggs lie at first partly within scattered cavities in the parenchyma and partly between the meshes of the same; later no cavities are to be seen and the ova are imbedded singly in the parenchyma; the eggs are surrounded by three shells.

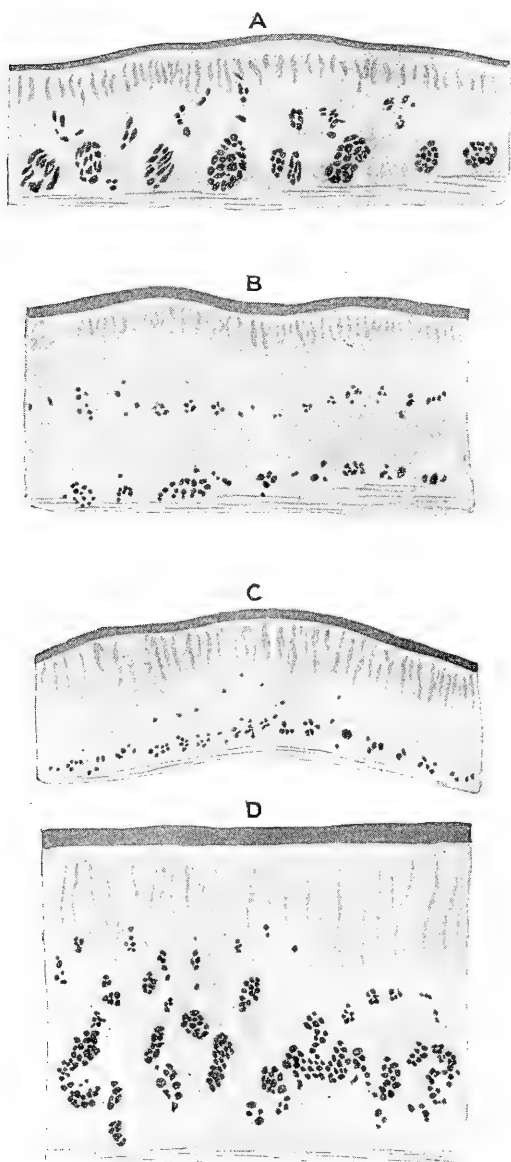
Hab. Ameiva surinamensis.

Oochoristica marmosæ, sp. n.

Of this new species I have been able to examine but a single specimen, which was obtained from an American Marsupial, *Marmosa elegans*. The specimen was not all in one piece; but, if the pieces were all of one individual, the length is 84 mm. Otherwise the length of the largest piece, which included the scolex, was 54 mm. The greatest breadth of a ripe proglottid is slightly under three millimetres. During life the posterior segments were extended to a length of rather more than twice their width. They were quite retracted by alcohol and became shorter than broad. The unarmed head has the usual four suckers, which are directed upwards. There is thus nothing distinctive in the external characters of this species. The generative pores are not visible, except by the section method; for they open anteriorly in each proglottid and their orifices are covered by an overlap of the proglottid in front. These pores alternate irregularly from side to side of the body as in all other species of *Oochoristica*.

In transverse sections through this tapeworm it may be seen that it agrees with *Oochoristica*, as opposed to *Linstowia*, in the comparative thinness of the cortical layer, which is less in diameter than the medullary layer. The muscular layers in the cortex have a characteristic arrangement (text-fig. 4, A), which

Text-figure 4.



A series of transverse sections through the cortex of various species of *Oochoristica* and *Linstowia*, to illustrate the arrangement of the longitudinal musculature.

A. *Oochoristica marmosæ*. B. *Linstowia ameivæ*. C. *L. echidnæ* or *semoni*.
D. *Oochoristica* sp.

may be compared, in the figure cited, with those of other and allied species (text-fig. 4, B, C, D). In the present species a delicate layer of transverse fibres forms the innermost layer of the cortex and separates it off from the medulla. Immediately outside of this is a layer of longitudinal fibres disposed in stoutish bundles separated from each other by considerable intervals. Outside of these again are scattered longitudinal fibres, which are here and there aggregated into small bundles of two or three fibres. The large internally situated bundles consist of 15-20 fibres apiece.

Text-fig. 4, B, illustrates a corresponding section through *Linstowia ameiva*, which I have already described*, and which shows plain differences from *Oochoristica marmosæ*.

For the purpose of comparison with these two species and to show the value as specific marks of the arrangement of the longitudinal muscles, I subjoin corresponding figures of a *Linstowia* from *Echidna* (text-fig. 4, C) which may be *L. echidnæ* or *L. semoni* (I have no means of deciding the point), and of *Oochoristica* (text-fig. 4, D), which is near to and possibly identical with *O. wagneri*, whose general anatomy has been described by myself lately†. In the former species (text-fig. 4, C) the longitudinal muscular layer is divisible, as in the other species, into two sheets, of which, as before, the innermost is the stronger. So much so, however, that the outer muscular sheath is reduced to a very few fibres. The inner stronger layer is not by any means so well developed as in the last two species: the bundles are smaller, that is, they contain fewer fibres, and they are not by any means so distinctly marked off from one another as in *Oochoristica marmosæ*; they resemble more *Linstowia ameiva*, a point of importance in view of possible generic identity.

The last species represented in the figure (text-fig. 4, D) is quite unlike any of the others, in that there is not a definite two-layered disposition of the muscular fibres. There is simply one irregular layer of bundles of varying sizes, that is, containing a variable number of muscular fibres, which together occupy a good deal of the space which lies between the subcuticular layer and the transverse muscular layer. It will be observed, however, that, on the whole, the larger bundles lie to the deeper side of the cortical layer, those more superficially placed being smaller. On the whole, the arrangement of the longitudinal muscles in this species is more like that of *Oochoristica marmosæ* than of the other two species figured, by virtue of the size of the bundles. But if we attempt to draw generic definitions from this character, it might perhaps be urged with equal force that the reduction of the muscles in *Linstowia semoni* sets that species apart from all the rest. In any case, it cannot be doubted that these muscles furnish very clear specific characters which have not been hitherto sufficiently represented in figures illustrating these two genera.

* *Supra*, p. 264.

† P. Z. S. 1911, p. 627.

In both transverse and longitudinal sections only two large longitudinally running trunks of the water-vascular system are to be seen. These two trunks, as is so often the case, are of quite different dimensions. The dorsal tube, which is very much smaller than the ventral, lies above it, sometimes also rather to the inside, and has thicker walls. This tube is so fine that I have occasionally been unable to find it in a given section, though it would appear to be quite a continuous vessel. Below lies the very much larger ventral tube. This is situated at some distance to the inside of the nerve-cord. In the existence of but two principal longitudinal water-vascular tubes the present species agrees with the other two forms which are found in South American Marsupials, and also with the recently described species named by Zschokke *Oochoristica rostellata**; in the latter case, however, the two tubes, dorsal and ventral, are of about the same calibre, as is shown in his figure of a transverse section through a proglottid of that worm. In longitudinal sections the same two tubes are always quite visible.

To these two principal longitudinal tubes on each side of the proglottid a third may be added, which is, however, not comparable with the additional tubes found in certain species of *Oochoristica* from S. American Edentates. One does not find in transverse sections six conspicuous longitudinal vessels such as are so plain in an *Oochoristica* from *Tamandua*, upon which I have recently reported to the Society. But, on the other hand, the anastomosis between the branches of the excretory network which pervades the segments does lead to the formation of at least short longitudinal trunks. I have observed such a one lying outside of the nerve-cord. The branches of the water-vascular system in this species are indeed very copiously developed. Four or five, or even more, large branches from the ventral vessels pass across the proglottids, and even more are directed towards the lateral margin passing across the nerve-cord. The whole body is, in fact, richly supplied by a plexus, of which the individual tubes are often wide. I have not been able to ascertain whether any of these branches perforate the cortex and reach the exterior of the body.

§ *Male Gonads and Ducts.*

The relative positions of the male and female gonads in this group are frequently made use of as a generic distinction. The present genus, *Oochoristica*, has been partly defined thus by Ransom†:—"Testicles numerous, surround female glands posteriorly and on the sides." The figure given of *O. rostellata* by Zschokke‡ is in accord with this definition; and so are certain of the figures given by v. Janicki§. Not, however, his illustrations of the species *O. bivittata* and *O. didelphydis*, which are

* Zeitschr. wiss. Zool. Bd. lxxxiii. 1905, pl. i. fig. 2.

† Bull. U.S. Nat. Mus. No. 69, 1909, p. 85.

‡ Zeitschr. wiss. Zool. Bd. lxxxiii. 1905, pl. i. fig. 3.

§ *Ibid.* Bd. lxxxi. 1906, pl. xx. figs. 5, 7, pl. xxi. figs. 18, 21.

for certain reasons (geographical distribution and host) to be compared particularly with that which forms the subject of the present communication. In these two species the testes are entirely posterior to the female gonads. It seems possible that some differences are to be accounted for by the state of contraction of the proglottids.

In *Oochoristica marmosæ*, in those proglottids where they are at the height of their development, the testes are mainly to be found at the sides of the centrally placed ovary and vitelline gland, which are themselves very large and occupy most of the central region of the proglottid, both dorso-ventrally and antero-posteriorly. The testes extend above the female gonads dorsally, and there is a single row of them posteriorly behind the vitelline gland—in fact, they occupy pretty well all of the available space within the proglottid. They are numerous—I have counted as many as 50 in a single horizontal section. Inasmuch as a single proglottid cut horizontally was displayed in 25 sections (*not* including sections through the cortex), the number of testes is obviously large, even though the first and last sections only show one or two testes. The largest number given by Zschokke in his review of the genus is 100 for *O. rostellata*. My species must considerably exceed that.

The vas deferens opens through the cirrus-sac into a genital cloaca. The *genital cloaca* is less conspicuous in this *Oochoristica* than it is in some other tapeworms. It is in depth about one-third of the length of the cirrus-sac, which is itself small, and has no marked specialization into regions such as occurs, for example, in *Eugonodæum ædicnemis**. It is narrow and tubular in horizontal section, and the cirrus-sac opens into it at its internal extremity. It is surrounded by muscle-fibres, which doubtless act as a sphincter. This orifice is in front of that of the vagina. The *cirrus-sac* is small and only extends back as far as the nerve-cord. It is as usual bottle-shaped, being wider posteriorly, where also the muscular wall is much thinner. I could discover no spines upon the contained cirrus, which widens out and becomes very muscular at its outer end. Altogether there is nothing remarkable about the cirrus-sac and cirrus of this *Oochoristica*. But its shape and size and the muscularity of its walls are important specific marks—for they differentiate it from *O. rostellata*.

The *vas deferens* issues from the cirrus-sac as a straight tube running parallel with the vagina. Later it forms a loose and not very extensive coil, and often bends backwards and breaks up into a number of branches, which again become subdivided to supply the individual testes. This region of the sperm-duct is of the nature of a network, for anastomoses exist between many of the branches. The walls of the finer branches of the sperm-duct and their communication are quite visible, even

* P. Z. S. 1913, p. 866, text-fig. 144.

under only moderately high powers; and when gorged with sperm they are not any more conspicuous.

§ *Female Gonads and Ducts.*

The *ovary* lies anteriorly in the proglottid, but is prevented from reaching the actual limit of the proglottid by the transverse uterus which lies in front of it. It consists of a central portion, which lies practically in the middle of the proglottid, and of two lateral wings. The latter are frayed out into numerous thick digitiform processes, which extend rather beyond the range of the posteriorly situated vitelline gland. In sections cut horizontally the digitiform outgrowths of the ovary have the appearance of circular or oval sacs filled with ova. They present the very closest resemblance to the sacs of the uterus which lie among them. The *vitelline gland* is rather smaller than the ovary, behind which it lies. It is very much of the same form, being prolonged laterally into blunt processes. The *vagina* runs at first a straight or slightly sinuous course behind the vas deferens; it then bends backwards and becomes dilated to form a cylindrical receptaculum seminis, which lies obliquely at an angle of about 45° with the longitudinal axis of the worm. The lumen of that part of the vagina which is nearest to the receptaculum is narrower than that of the outer section of the vagina; I have observed cilia lining the vagina at a considerable distance from the external orifice. The *receptaculum seminis* is generally full of sperm. In many cases I have found numerous ova within it. I have not observed autocopulation in this species.

§ *The Uterus and the embedding of Ova in the Parenchyma.*

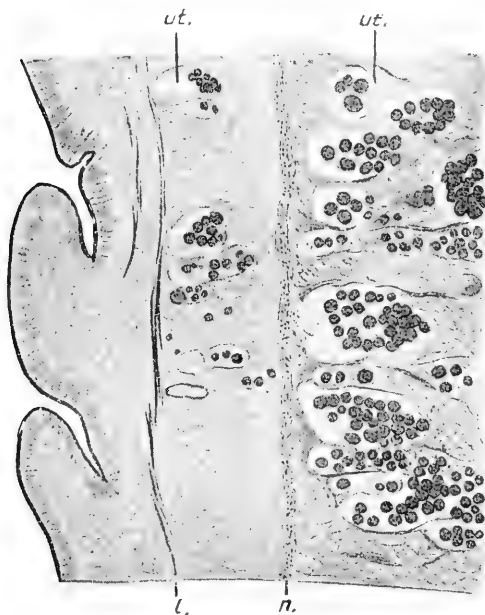
In the genus *Oochoristica* the uterus is not a prominent feature—"Die rasche Entwicklung und der ebenso prompte Zerfall des ursprünglich ventral angelegten Uterus charakterisiert, soweit genauere Untersuchungen ein Urtheil erlauben, das ganze Genus *Oochoristica*," writes Zschokke* in a general survey of the characters of this genus. No precise figures are given as to the duration of the uterus by Zschokke in the species (*O. rostellata*) described in the memoir from which the above quotation has been made. I find myself that, in the species which I describe in the present paper, the uterus is quite obvious in 34 segments, a space of about 10 mm. in length, which is a very appreciable portion of the entire body-length.

The uterus is seen on a general examination to consist of numerous closely adpressed circular to oval chambers, which are more or less filled with eggs. This system of cavities is at first mainly ventral in position. In a series of horizontal sections the ventralmost show only uterine cavities, which extend up to

* Zeitschr. wiss. Zool. lxxxiii. 1905, p. 63.

the anterior, but not up to the posterior, margin of the segment. In fact, they completely underlie the ovary, but not always completely the vitelline gland. In the earliest proglottids which show a uterus, the latter lies only anteriorly and, of course, ventrally. The uterus in the first two or three segments in which it is found consists merely of a transverse tube anteriorly and ventrally, the two ends of which are dilated into two or three more or less oval diverticula, which are thus quite lateral in position. It seems, in fact, to resemble closely the uterus of *Oochoristica rostellata*, as represented in Zschokke's figure*.

Text-figure 5.



Part of a horizontal section through three consecutive segments of *Oochoristica marmosæ*, to show the extension of the uterus laterally.

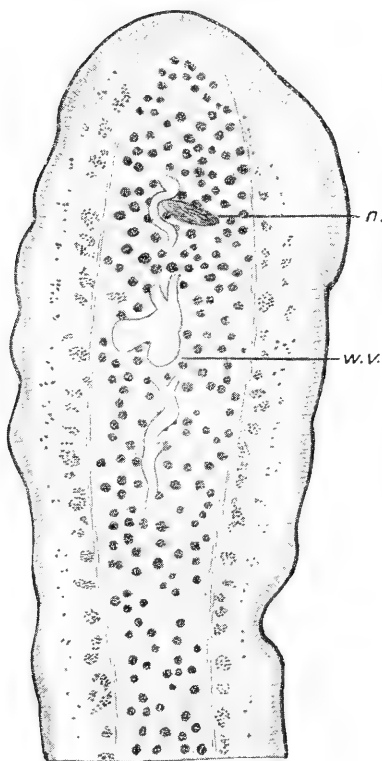
l. Longitudinal muscles. n. Nerve-cord. ut. Uterus.

In later proglottids (text-fig. 5) the uterine cavities range through the medulla much more extensively, and also penetrate into the cortical layer. Finally, the cavities of the uterus are obliterated by growths of the parenchyma, and the individual eggs (or rather embryos) come to lie singly, filling up the entire interior of the proglottid. The development of the uterus, in fact, seems

* Zeitschr. wiss. Zool. Bd. lxxxiii. 1905, Taf. i. fig. 2, v.

to be much as in *O. rostellata*, though Zschokke does not mention the invasion of the cortical layer by uterine spaces. It is to be noted, however, that in my species the extension of the embryos into the cortical layer mainly takes place laterally, and not dorsally or ventrally to any great extent, though here and there I have observed embryos in these regions of the cortical layer.

Text-figure 6.



Half of a transverse section through a nearly completely mature proglottid of *Oochoristica marmosæ*, showing the embryos scattered through the parenchyma.

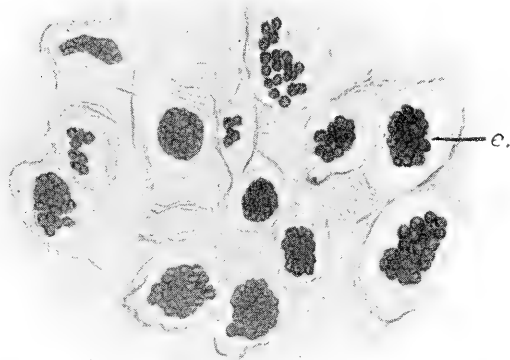
n. Nerve-cord. *w.v.* Water-vascular tubes.

Particularly is the latter the case with the quite mature proglottids, where the embryos are surrounded by their shells.

We may note before proceeding further with the description of the embryos the differences which the uterus shows in the two species dealt with in the present paper. In *Oochoristica marmosæ* the uterus consists of a well-marked posteriorly situated transverse

tube, which gives off oval diverticula laterally. These cavities have well-marked walls, which, however, do not seem to be independent of the surrounding parenchyma; they have no special lining of their own. Later the cavities are multiplied, and the eggs from the very first are confined to these cavities and never lie in the parenchyma between them. The uterus, moreover, exists throughout a good many proglottids. On the other hand, in *Linstowia ameivae* the uterine cavities are less strongly marked off and altogether less definite; they do not form a coherent group and exist for a much shorter period. Moreover, from the very first the ripe ova do not all of them lie within these cavities; they are continually to be found imbedded in the parenchyma between the uterine cavities. The uterus seems to be degenerating in this species as compared with that of *O. marmosa*.

Text-figure 7.



A portion of the same more highly magnified.

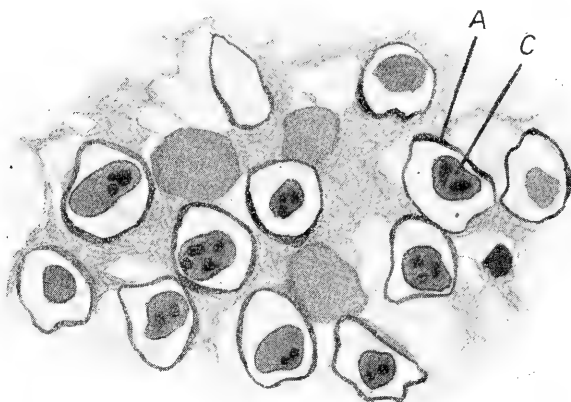
The membranes surrounding the embryo (e.) are not yet formed.

The disappearance of the uterus in *Oochoristica marmosa* is followed by a stage (illustrated in text-fig. 6) in which the eggs, which have by this time developed into embryos, are uniformly scattered through the medulla (occasionally invading the cortical layer, as already mentioned) for a considerable number of proglottids, which I am unable to state exactly; the scattered embryos possess no definite shell. They lie (text-fig. 7) in cavities of uniform size separated by meshwork from each other. These cavities resemble in every way the cavities of the parenchyma in various tapeworms, where there is no question of uterine cavities. It must be admitted, however, that such a space as there is round an individual embryo is to be looked

upon as the remains of the uterine cavity. Those who have figured the embryo of *Oochoristica* have, as a rule, not represented this stage, which, however, is not the case with Lühe*, who has represented such embryos in "*Tænia*" *megastoma* Dies.

The first membrane to be formed is a fine one immediately surrounding the embryo. Later on a much thicker and deeply staining outer membrane is formed, which lines the "capsule" of the parenchyma in which the embryo lies. Between these two there is no third membrane. There is thus an important difference between the present species and *Linstowia ameivæ* (cf. text-figs. 3, 8), also described in the present communication to the Society. In *Oochoristica marmosæ* (text-fig. 8) the eggs

Text-figure 8.



A later stage than that represented in text-fig. 7.

A. Outer membrane. C. Embryo surrounded by thin inner membrane.

have therefore a much clearer appearance, owing to the larger empty space which separates the embryo from the outermost membrane. As to this latter membrane, it is apt to be hexagonal in transverse section, owing to its separation from the embryo and close adherence to the parenchymal walls; and it is not unreasonable to think that it may be a product of the parenchyma rather than of the embryonic cells. This appears to be the opinion of Zschokke† with regard to the uterine ova of *Linstowia semoni*, for he writes: "Die ganze Markschrift ist . . . vollständig angefüllt von derbwandigen, rundlichen Bindegewebskapseln, die sich gegenseitig einengen. Jede

* Arch. f. Naturg. 1895, pl. xi, fig. 15.

† "Die Cestoden der Marsupialia, etc.," in Semon's Zool. Forschungsreise, etc., Jan. 1898, p. 368.

Kapsel beherbergt in der Regel ein einziges Ei." The structure figured by Zschokke *, and to which he refers in the above quotation, seems to be of the nature of a membrane and to be therefore quite like the membrane to which I here refer in *Oochoristica marmosæ*. It does not suggest a cellular layer such as I have figured in *Oochoristica* sp. † As to the number of shells, whether thrown off by the embryo or not, which surround the embryo in the genus *Oochoristica*, there appear to be differences among different species. Cohn distinctly represents three shells ‡ in *O. surinamensis*, while Marotel § asserts the presence of only two in the *Oochoristica* of the European Badger, *O. incisa* of Railliet ||.

§ Affinities of the Species.

I have described this species as an *Oochoristica*; into the question of the definition of this genus I propose to enter later. In the meantime, it is necessary to enquire whether—apart altogether from the question of genus—it may not be specifically identical with *Linstowia brasiliensis* ¶ from *Didelphys tristriata*. There is, I think, no possibility of confusing the two species, in spite of many points of general resemblance. In the first place, the simplicity of the water-vascular system of Dr. v. Janicki's species distinguishes it from mine. Furthermore, the fact that in *Linstowia brasiliensis* the ripe eggs of the posterior segments are limited to the lateral areas of the segments militates against the identity of the two species now under consideration. These differences appear to me to be sufficient, without going into a more detailed comparison between *Linstowia brasiliensis* and *Oochoristica marmosæ*. The same remarks apply to *L. iheringi* **.

Oochoristica didelphydis is too small a species (it measures only 15 mm. in length) to be confused with the present one. Furthermore, the scolex was absent, which increases the difficulties of identification. But it agrees with my species in having only two lateral vessels, of which the dorsal has a very fine lumen. On the other hand, the transverse tube is quite simple, which is not the case with that of *O. marmosæ*. The obliquely directed cirrus-sac of *O. didelphydis* contrasts with the perfectly straight one of *O. marmosæ*. The fact that in the former species the vagina opens on to the exterior in front of the cirrus-sac appears to me to be such an important difference, not only from my species, but also from the species of the genus *Oochoristica*, that it leads me to doubt the generic identity of these forms. And I would again point out that while the vagina of *O. marmosæ* is perfectly straight, that of *O. didelphydis* is much coiled. This appears to me to be quite a salient

* Loc. cit. pl. xxiv. fig. 7.

† P. Z. S. 1913, p. 875, text-fig. 149.

‡ Arch. f. Naturg. 1903, p. 65, fig. 9.

§ C.R. Soc. Biol. 1899, p. 21.

¶ Loc. cit. t. cit. p. 23.

|| v. Janicki, Zeitschr. wiss. Zool. lxxxi. p. 507.

** Zschokke, C.B.I. Parasit. xxxvi. 1904, p. 51.

difference, and adds to the possibility of generic difference. Indeed, v. Janicki admits the uncertainty of the inclusion of this species within the genus *Oochoristica*. No information is given of the ripe ova; but a small circular space lying in front of the ovary and marked in his fig. 5 with a "?" is possibly to be regarded as the uterus. In any case, quite apart from the generic identity of "*Oochoristica*" *didelphydis*, there can be no possible comparison between this species and *Oochoristica marmosæ*. The points of difference are too many and too important.

In comparing *Oochoristica marmosæ* with other species of the genus, habitat comes first into consideration and then the systematic position of the host. There are only two species of *Oochoristica* from South American Marsupials known at the present time; and these are *O. bivittata* and *O. didelphydis* recently described by v. Janicki*. *O. bivittata* is a much more slender worm than the one described here by myself; the greatest diameter is only .9 mm. It agrees generally in the unarmed scolex, in the fact that the vagina opens behind the cirrus-sac, and in the imbedding of the ripe eggs singly in the parenchyma, and in smaller details, which are, nevertheless, of systematic importance. There is, in fact, no doubt as to the generic identity of the two worms. The differences, however, are quite of specific value. The complication of the excretory system of *O. marmosæ* contrasts with the simple transverse vessels of *O. bivittata*. It is to be noted, however, that in all three species from *Didelphys* (the genus *Marmosa* but slightly differs from *Didelphys*) there are only two main longitudinal trunks—a point of similarity which is of interest. The generative organs are quite unlike in the two species in a number of features. The position of the gonads contrasts, and the testes are very few in number, in *O. bivittata*. This may, however, be partly due to the maturity of the segments, in one of which they are figured as not exceeding five in number clustered together behind the vitelline glands. Finally, the ripe eggs, though scattered singly as in other species of *Oochoristica*, are limited to the sides of the proglottids in *O. bivittata*.

I conclude with a definition of the new species, which is as follows:—

***Oochoristica marmosæ*, sp. n.**

Length at least 54 mm.; diameter 2.8 mm. Scolex unarmed, with suckers directed forwards; genital pores anteriorly situated in proglottid, alternate. Cortex not so wide as medulla. Longitudinal muscles forming a layer of bundles consisting of 15 or more fibres, above which are scattered fibres. Water-vascular system consisting of two longitudinal vessels on each side connected by a rich plexus of rather large branches. Testes very numerous,

* "Studien an Säugethiercestoden," Zeitschr. wiss. Zool. lxxxi. 1906, p. 505; and a preliminary account in Zool. Anz. xxvii. 1904, p. 770.

filling all the available space in the proglottid; cirrus-sac small, opening into a genital cloaca in front of vagina; sperm-duct with a loose coil dividing up into a meshwork of ductules. Ovary anterior in position; vagina with cylindrical receptaculum ovarum. Uterus consists of a posteriorly situated and transverse tube, from which arise numerous diverticula, extending ultimately through most of proglottid; uterus finally disappears, leaving embryos scattered singly throughout parenchyma, extending here and there into cortex. Embryos with two shells.

Hab. American Marsupial, *Marmosa elegans*.

§ *The Genera Oochoristica and Linstowia.*

The fact that *Linstowia* and *Oochoristica* are placed in separate families by systematists at present has tended of itself to exaggerate the differences which exist between these genera. Their real propinquity, however, becomes very apparent when we use the "Key to Genera" devised by Mr. B. H. Ransom*. In this dichotomous table we pursue the two genera side by side until the very last of the characters made use of; they are in this differentiated by the thickness of the cortical layer and the position of the testes in the proglottid. It should be noted that this dichotomous table and the subsequent generic definitions† given by Ransom were published after the information gathered by Zschokke and v. Janicki had been put forward.

When we come to look into the characters of the known species, including those described in the present communication, that have been referred respectively to one or other of the genera *Linstowia* and *Oochoristica*, it does not appear to be at all an easy matter to draw many hard and fast lines of separation. The first-described species of *Linstowia*, not then referred beyond *Tenia* by its original describer‡, has been investigated in further detail by Zschokke§. The salient characters of this worm are the following:—The cortex is thick||; the longitudinal muscle-bundles are in two rows, of which the inner is the thicker, but the bundles have not more than four or five fibres each; the genital cloaca is deep; the cirrus-sac is very large; the vas deferens is coiled and dilates posteriorly, just before it begins to divide, into a kind of vesicula seminalis; the testes extend through the proglottid dorsally; the vitelline gland is quite posterior in position and nothing lies behind it. The excretory tubes lie side by side, and are formed by a transverse vessel in each segment as well as by a network.

Zschokke gives in the same work a fuller account of a second species, viz. *Linstowia semoni*, an example of which serves to fill up certain lacunæ in the generic characters. Of this worm

* Bull. U.S. Nat. Mus. No. 69. 1909, p. 53, &c.

† *Loc. cit.* pp. 65 & 84.

‡ D'Arcy Thompson, Journ. Roy. Micr. Soc. 1903.

§ Zschokke in Semon's Forschungsreise, etc., 1898, pl. xiv. figs. 1 & 2.

|| Thompson, *loc. cit.* pl. v. fig. 8. A transverse section is not figured by Zschokke.

there is no transverse section figured to show the relative thickness of the cortex. The water-vascular system, not figured in *L. echidnæ*, has as main trunks two tubes on each side, which later lie parallel, and not one above the other, which is the case anteriorly; of these the dorsal tube lies to the outer side of the ventral. There is also a transverse trunk to be seen in each segment. The vagina in this as well as in the last species possesses a dilatation usually termed the receptaculum seminis. The uterus "forms a thin-walled folded tube where the wall is early lost"*, and the eggs come to be imbedded singly in the parenchyma. To these descriptions of the two species it should be added that in both the scolex is unarmed, that the genital pores alternate, and that there is nothing remarkable in the structure of other organs which have not been mentioned.

If we contrast with these species certain forms which have been referred to the genus *Oochoristica* from Edentates rather marked differences at once appear. In such forms as *O. wagneri* and the allied form which I have myself † lately described also from the Lesser Anteater, which may or may not be identical with it, we find the following assemblage of characters. While they agree with the members of the genus *Linstowia*, already referred to, in the unarmed scolex, the alternate generative pores, and the imbedding of the ripe eggs singly in the parenchyma, they differ by the much more complex water-vascular system consisting of six longitudinal tubes; they have also a small cirrus-sac which does not extend far into the body, not reaching much if anything beyond the nerve-cord. If these two groups of species comprised all that were known, the separation of the two genera would be quite easy and obvious. But there are forms which render such a demarcation impossible.

In *O. rostellata* of Zschokke ‡ there are but two water-vascular vessels; though these vessels are superposed instead of lying side by side as in *Linstowia*. On the other hand, in *Linstowia iheringi* and *L. brasiliensis* the cirrus-sac is as small as in *Oochoristica*! While in the species described in the present paper as *Linstowia ameivæ*, the cirrus-sac is large (as in the Australian members of the genus *Linstowia*), and the testes are as markedly behind the ovaries as in Janicki's species *Oochoristica bivittata*. As for differences in the relative thickness of the cortex and medulla insisted upon by many, I can see no difference worth mentioning in the figures of *Oochoristica wagneri* and *Linstowia brasiliensis* given by v. Janicki §.

It is thus next to impossible to separate the genera if we accept the present distribution of species among them. Nor is the matter ameliorated if we make the planes of division somewhat different. It had occurred to me to separate off the

* For the species of Australian *Linstowia*, see also Zschokke in Zeitschr. f. wiss. Zool. Bd. lxxv. (1899).

† P. Z. S. 1912, p. 627.

‡ Zeitschr. wiss. Zool. Bd. lxxv.

§ Zeitschr. wiss. Zool. Bd. lxxxi, text-fig. 4, p. 534, & pl. xx. fig. 2.

Australian forms limited to that country and to the two groups Marsupials and Monotremes. Here geographical range and the systematic position of the host concur with unusually large cirrus-sac as an anatomical character. But one of the two species, viz. *Linstowia semoni*, has a distinctly larger cirrus-sac than *L. echidnae*; and in my species *L. ameiva* the cirrus-sac is not much smaller than that of *L. echidnae*. One structural feature occurs to me as being of possible use in better defining the two genera *Linstowia* and *Oochoristica*. But it is so little known that it cannot be used for the present and may after all turn out to be worthless. This concerns the imbedding of the ova in the parenchyma after the disappearance of the uterus.

I have pointed out *, in describing the ripe eggs of a species of *Oochoristica*, that they are encircled by a cellular layer suggestive of a commencing paruterine organ like that of *Davainea*, etc.

If it be found that this character also signalizes other South American species from Edentates a separation might well be made. Furthermore, it is quite possible that the condition of the uterus may serve as a dividing-line, as it certainly appears to do in the case of two other mutually related genera, viz. *Inermicapsifer* and *Zschokkeella* †. The kind of difference that is meant by this suggestion is that shown by the two species described in the present paper, and has been put forward in detail above, accompanied by illustrations (text-figs. 2 & 5). In the meantime, it does not seem possible to form a reasonable definition of the two genera, and I am strongly of opinion that there are no grounds at all for placing *Oochoristica* and *Linstowia* in separate families.

* In a paper upon a new genus *Eugonodæum* in P. Z. S. 1913, p. 875, text-fig. 149.

† See P. Z. S. 1912, p. 607.

18. The Malay Race of the Indian Elephant, *Elephas maximus hirsutus* *. By R. LYDEKKER, F.R.S., F.Z.S.†

[Received February 24, 1914: Read March 17, 1914.]

(Text-figures 1-3.)

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Description of the new race		288

Thanks to the Trustees of the estate of the late Mr. Rowland Ward, the Natural History Branch of the British Museum has received the mounted skin of the young Malay Elephant which died in the Society's Gardens during the latter part of last year. While yet alive, the extraordinary hairiness of this animal attracted the attention of naturalists; and this feature, coupled with a peculiarity in the form of the ears, seems so well marked and so distinctive as to justify the recognition of the Malay Elephant as a distinct local race of the Asiatic species.

Text-figure 1.



Young Malay Elephant when alive in the Society's Gardens.

As I learn from Mr. Pocock, this Elephant came from the Kuala Pila district of the Negri Sembilan province of the Malay

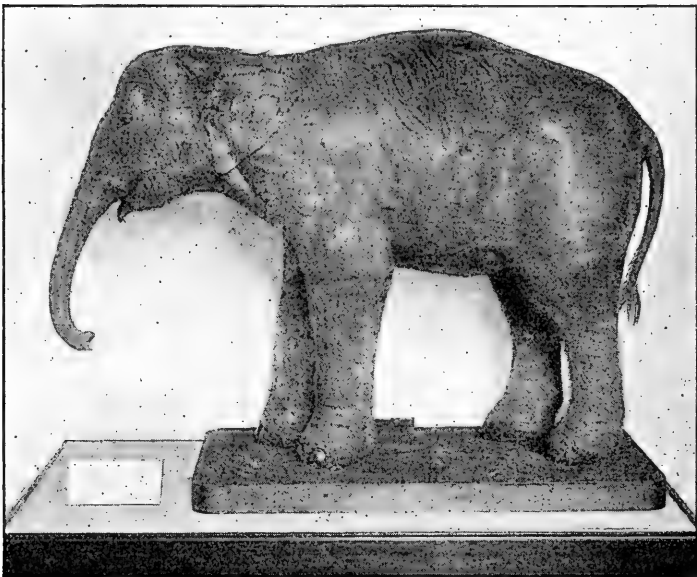
* [The complete account of this new subspecies appears here, but since the name and a preliminary diagnosis were published in the 'Abstract,' No. 130, 1914, it is distinguished by being underlined.—EDITOR.]

† Published by permission of the Trustees of the British Museum.

Peninsula, and is believed to have been about three years old at the time of its death. As shown in the accompanying photograph from life (text-fig. 1), it has a somewhat stunted appearance—suggestive, at first sight, of its belonging to a small race,—the height of the specimen, as mounted, being about 3 feet 8 inches. This stunted appearance may, however, be merely due to the effects of early captivity, for Mr. T. R. Hubback, in his book on *Elephant and Seladang Hunting in the Federated Malay States* *, records that the Elephants of the Negri Sembilan are of ordinary size, although of late years most of the big bulls have been killed off. He also mentions that practically all the bulls are tuskless, and very generally have one tusk much smaller than the other.

Before proceeding further, it may be mentioned that it is very difficult to obtain definite information with regard to the hairiness or otherwise of Indian Elephant calves—that is to say, in those of the typical Indian race of the species. Dr. Möbius † has, indeed,

Text-figure 2.



Newly born Indian Elephant in the Natural History Museum.

shown that young Elephants may have remnants of a soft hairy coat comparable to the under-fur of the Mammoth, and the young Elephant born—from a presumably Indian mother—in the

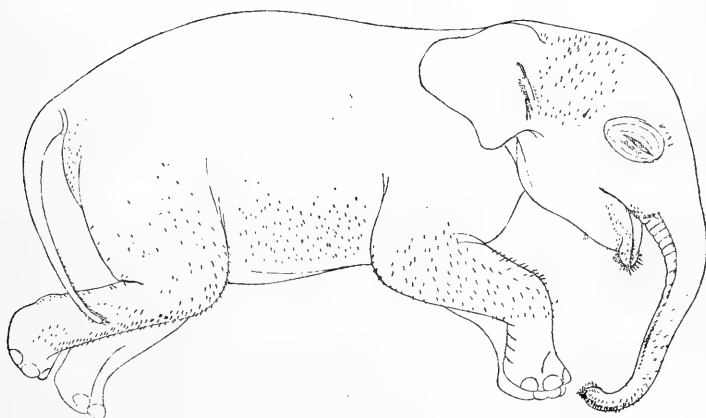
* London, 1905, p. 63.

† Sitzber. k.-preuss. Ak. Wiss., Math.-Nat. 1892, p. 527.

Society's Gardens in 1902, the mounted skin of which (text-fig. 2) is exhibited in the Natural History Museum, has a considerable portion of the body clothed with a somewhat sparse coat of rather short, soft, rufous hair, which also forms a fringe to the margins of the ears. There likewise appears to be a certain amount of hair of a similar type shown in the photograph of the young Indian Elephant born in Copenhagen in 1912.

On the other hand, from the fact that writers like G. P. Sanderson and W. T. Blanford make no mention of the hairiness of Indian Elephant calves, it seems probable that in many cases the skin may be more or less nearly bare, although it must be confessed that information with regard to this matter appears to be very scant and defective. Still, it may be taken for granted that if Indian-born Elephant calves exhibited hairiness in any way comparable to that of the young Negri Sembilan animal, the fact would have been recorded in textbooks on Indian natural history and sport.

Text-figure 3.



Outline of a Fœtus of a Siamese Elephant.
(From Toldt, Denks. k. Ak. Wiss. Wien, 1913.)

It is, however, very noteworthy that Mr. K. Toldt* has recently described and figured an advanced fœtus of a Siamese Elephant (text-fig. 3), in which the sides of the crown of the head, the terminal half of the trunk, the point of the lower lip, the under-parts, the greater portion of the limbs, and the hind aspect of the buttocks are sparsely covered with short bristly hairs, which would doubtless have attained much greater development after birth. Nor is this all, for if Mr. Toldt's figure (text-fig. 3) be compared with that of the young Indian† Elephant shown in

* Denks. k. Ak. Wiss. Wien, vol. xc. p. 259, 1913.

† The term "Indian" is here used *strictu sensu*.

text-fig. 2, it will be at once evident that there is a marked difference in the shape of the ears in the two specimens.

To describe this difference in words is very difficult, and it is most easily apprehended by contrasting the figures. It may be mentioned, however, that in the Indian Elephant—both young and adult—the ear is distinctly triangular, owing to the great development of the descending lobe, and that its longer diameter is vertical. In the Siamese calf, on the other hand, the descending lobe is less elongated and the postero-inferior border placed less obliquely, while there is a greater development of the postero-superior border. In consequence of this—making due allowance for the turning-forward of the lower part of the postero-superior border, which may apparently also occur in Indian calves*,—the whole lower half of the ear forms, roughly speaking, an obliquely hung half-square, with somewhat emarginate borders.

Now the ear of the Negri Sembilan calf accords very closely in general type with that of the Siamese foetus, the chief differences being the minor degree of emargination of the borders and the direction of the antero-inferior border, which is inclined downwards and backwards in a much more marked degree. The differences are, however, slight and, coupled with the hairiness of both, indicate that the two represent either two closely allied races or a single and slightly variable race. As regards hairiness, the Negri Sembilan calf has bristly black hairs on most or all of the regions where these occur in the Siamese foetus; and, in addition, a large amount of softer and longer black hair on the back and flanks, as well as on the under surface of the lower jaw.

The tail is considerably longer than in the Indian calf, but since, according to Sanderson, there is considerable variation in this respect among Indian Elephants—which may or may not eventually prove to be of racial value,—I do not for the present propose to take any account of this feature. The great difference in the contour of the ear, coupled with the excessive development (at least in some instances) of black and in part bristly hair in the juvenile condition, seems sufficient to justify the separation of the Elephant of the Malay Peninsula as a distinct race, under the name of *Elephas maximus hirsutus*†. That the Siamese Elephant is near akin to this race seems certain, but whether it should be included therein, or should be regarded as a race by itself, may be left for future consideration.

It should be added that I have no means—except on the ground of geographical isolation—of distinguishing the Malay Elephant from *E. maximus sumatranus*, the description of that race‡ not being comparable with the specimens forming the subject of the present communication.

* According to Sanderson, 'Thirteen Years among the Wild Beasts of India,' p. 60, the permanent backward folding of the margin of the ear in Indian Elephants does not take place till the sixth or seventh year.

† Abstract P. Z. S. 1914, p. 20 (March 24th).

‡ See Sclater, Nat. Hist. Rev. vol. ii. p. 72, 1862, and Falconer's 'Palæontological Memoirs,' vol. ii. p. 256, 1868.

19. Fauna of Western Australia.—I. The Onychophora of Western Australia. By W. J. DAKIN, D.Sc., F.L.S., F.Z.S., Professor of Biology, University of Western Australia.

[Received January 12, 1914: Read March 17, 1914.]

(Text-figure 1.)

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There is a tendency for our knowledge of the species of *Peripatus* in Western Australia to become somewhat confused. Three species have been described, namely:—

I. *Peripatus leuckarti*, var. *occidentalis*.

syn. *Peripatoides occidentalis*.

II. *Peripatoides gilesii* Spencer.

III. *Peripatoides woodwardi* Bouvier.

Of these three, *Peripatoides occidentalis* was the first to be made known. The species was described by Fletcher, from specimens collected by a Mr. Lea at Bridgetown, South-Western Australia (Proc. Linn. Soc. N.S.W. 1895 (2), x.). The diagnosis reads as follows:—" *P. leuckarti* Säng, var. *occidentalis*, var. nov. With 15 pairs of walking legs; outer jaw-blades without an accessory tooth."

Beyond a brief reference to the colour, no further description is given and unfortunately no figures accompany the paper.

Twelve years later, *Peripatus* was found in another locality (Armada) in Western Australia, not far from the capital, Perth, and specimens collected by Mr. H. M. Giles were sent to Professor Baldwin Spencer. The latter considered them to belong to a new species, and, in a short paper read September 1908 (but not published until March 1909), named the species *Peripatoides gilesii* after the collector*.

In the year 1905, however (that is two years before the specimens were sent by Giles to Spencer), the German Expedition of Michaelsen and Hartmeyer captured a number of *Peripatus* at Lion Mill, a place also near Perth. These specimens were sent to Bouvier, and his description with an account of the anatomy was published in the Reports of the Expedition in 1909†. Bouvier recognised these specimens as belonging to a new species, which he named *Peripatoides woodwardi*.

It will be noted here that the appearance of the papers of both

* Proc. Royal Soc. Victoria, vol. xxi. (New Series), pt. ii. (1909).

† 'Die Fauna Südwest-Australiens,' Band ii. (Jena, 1908-09).

Spencer and Bouvier in the same year precluded either from seeing the publication of the other.

After consulting both these papers, in order to name certain specimens captured in almost the same district, the probability of *Peripatoides gilesii* and *Peripatoides woodwardi* being one and the same did not seem very remote. Further investigation has made the probability an actual fact.

My first specimens, numbering 14 in all, were collected on the afternoon of July 5th at a spot not far from Mundaring Weir. They were obtained at distances varying from 3 to 4 yards to 80 yards from a small streamlet 2 or 3 feet in breadth and a few inches deep, with banks 5 or 6 feet in height. The specimens occurred lying under small logs, broken branches from the trees, which were about 1 to 3 feet in length and 2 inches in diameter. Occasionally they are to be found under larger logs. Furthermore, the animals were not distributed uniformly in the area examined. They appear to occur on patches of ground the character of which became familiar after a time, so that one could speak of a "likely spot." The ground was not particularly damp and was often in brilliant sunlight, there being little shade from the scattered "blackboys" and eucalypts. In most cases the surface of the ground was not covered with vegetation, but was sandy or sand mixed with organic debris. Two, or even three, specimens might be found under the same log, but usually only one.

These specimens from Mundaring Weir agreed with Bouvier's description of *Peripatoides woodwardi*. In order to be more certain of their relation to *Peripatoides gilesii*, I asked Professor Spencer for the type-specimens of the latter, and he very kindly had these sent to me, together with a microscopic preparation of the jaws.

Dimensions. According to Bouvier the length of his specimens varied from 10.5 mm. to 21 mm. This is stated by him to be almost the size of *Peripatoides orientalis* and a little larger than *Peripatoides occidentalis*.

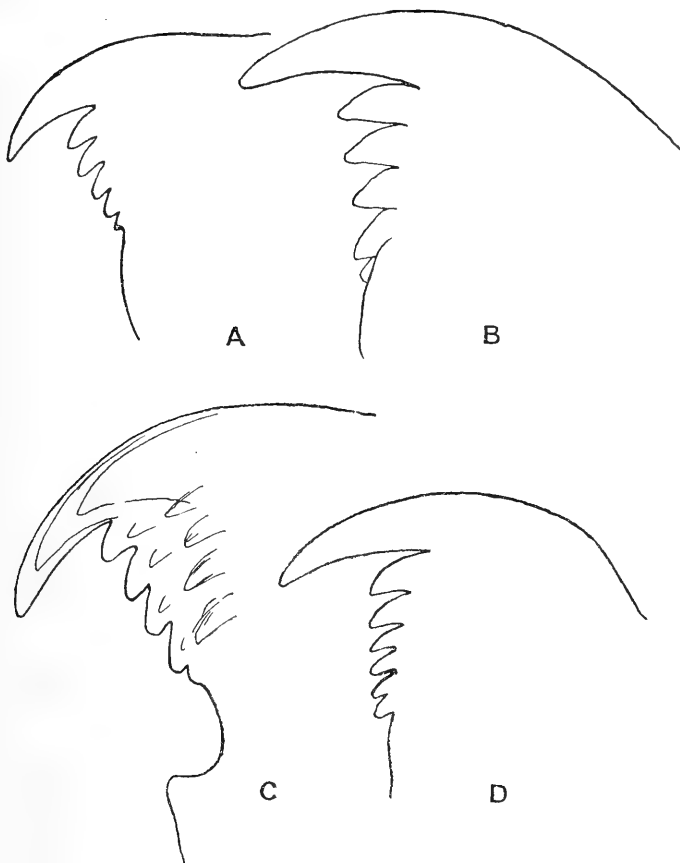
Spencer's specimens of *Peripatoides gilesii* measured 22 mm., 25 mm., and 27 mm., respectively. The discrepancy in size means nothing, for in Bouvier's case the individuals were preserved and contracted. My specimens from Mundaring Weir ranged in size from 12 mm. to 34 mm. The length of 34 mm. was that of the largest when outstretched and walking. On being touched it contracted to 28-30 mm., and on fixation it diminished still further to about 22 mm. It is obvious therefore that one must be careful in deducing any differences from dimensions.

Colour. So far as colour is concerned, the specimens collected at Mundaring can be roughly sorted out into two groups—a group in which brown-red predominates and a group in which green-grey of a dull shade is the dominant colour. Spencer's specimens vary too in a similar way, and he refers in his paper to greenish-yellow and reddish-brown specimens. Bouvier's specimens are again the same, and he described blue-green to black individuals and others of a fawn-yellow, sometimes pale, sometimes red.

Spencer mentions further a broad lighter band just above the level of the legs. Bouvier refers to a longitudinal band on each flank above the bases of the legs, the colour of which is yellow-red, and poor or even lacking in dark-coloured papillæ.

The Mandibles. The mandibles are accounted as one of the chief diagnostic features of the species *Peripatoides gilesii*.

Text-figure 1.



Inner jaw-blades from the specimens of *Peripatoides* under consideration.

A. From type-specimens of *P. gilesii* Spencer.

B. Bouvier's figure of jaw from *P. woodwardi*.

C & D. Jaws from other individuals of same species.

According to Spencer the first jaw is simple in all specimens, there being no accessory tooth. The second jaw has four clearly marked and one minute accessory tooth. The above figure (text-fig. 1) illustrates the jaw from Spencer's specimen, two of the jaws from my specimens, and the figure given by Bouvier for the left mandible of *Peripatoides woodwardi*.

Bouvier describes the jaw as follows:—

“Les mandibules (fig. 3) sont dépourvues de dents accessoires sur leur lame externe, comme dans les *Peripatoides suteri*, *novæ-zealandiæ* et *occidentalis*, et contrairement à ce que l'on observe dans le *Peripatoides orientalis*; leur lame interne présente 5 dents accessoires.”

The description and the figures (text-fig. 1, A, B) indicate that there is no difference between the mandibles described by Spencer and those described by Bouvier.

There is, however, an interesting variation which seems to have escaped both Spencer and Bouvier, probably owing to the examination of jaws from only one individual. Having mislaid my first preparation, which agreed with that of Spencer, I mounted the jaws from a second individual. It was rather difficult in this specimen to make out the fifth tooth, although it was present (text-fig. 1, C). Wishing to procure a more definite example, I removed the mandibles from a third individual, the largest one in my collection. To my surprise there were *six* very definite teeth on the inner lamella of the jaw (text-fig. 1, D). Thus the actual number of accessory teeth given by Bouvier and Spencer may be exceeded.

The Feet. The number of claw-bearing legs is perhaps the most important character in the diagnosis of the species *Peripatoides gilesii* and of *Peripatoides woodwardi*. Both Spencer and Bouvier accentuate the number of legs, which in each case is said to distinguish their species from all other Australian forms except *Peripatoides suteri*. In both species, however, the number is sixteen!

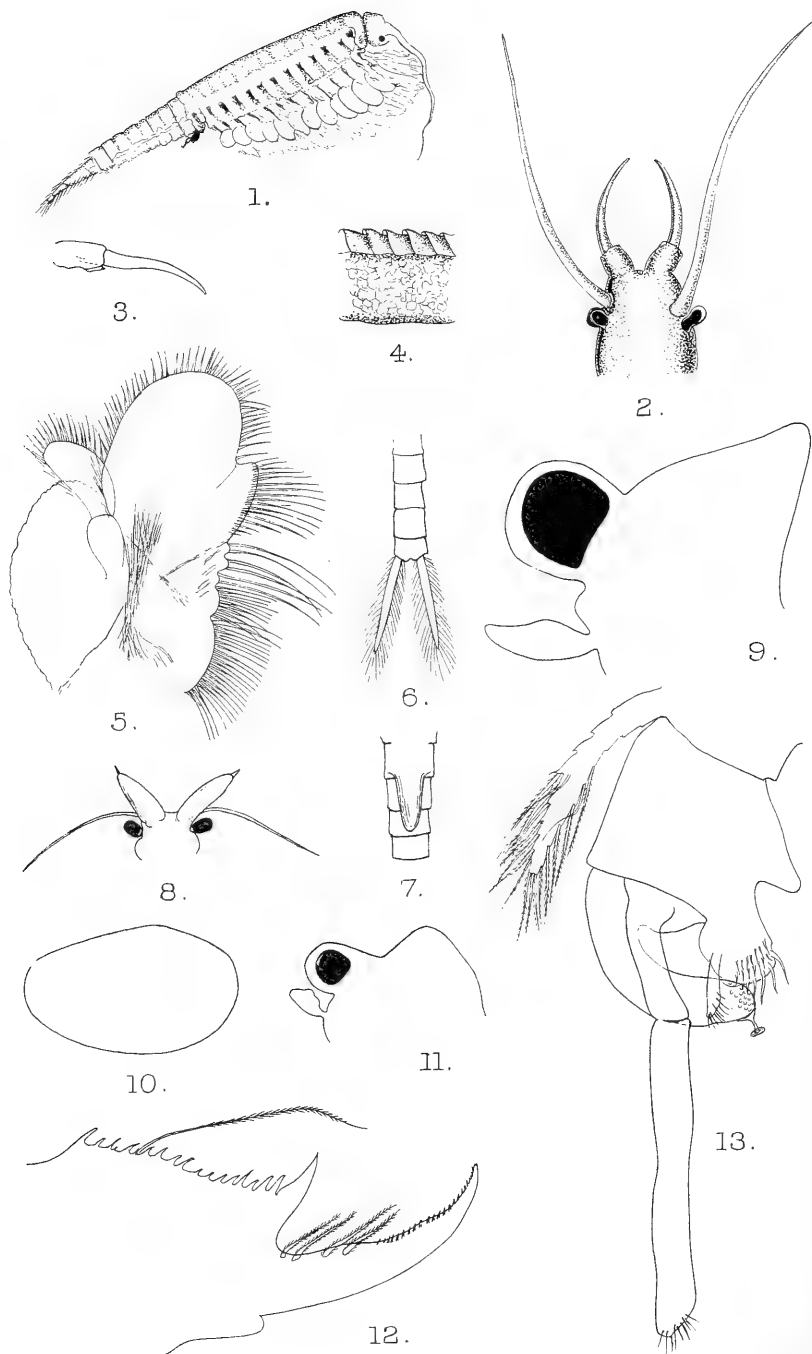
Spencer writes, “The number of legs together with the structure of the jaws, serves to distinguish this species from all other Australian species of either of the genera *Peripatoides* or *Ooperipatus*.”

Bouvier states that “Le *Peripatoides woodwardi* ressemble au *Peripatoides suteri* et se distingue de tous les autres Peripatopsides Australasiens par la présence constant de 16 paires de pattes.”

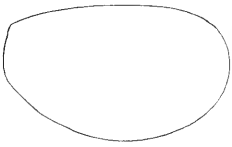
Thus, so far as the supposed characteristic features are concerned, the specimens of Spencer and Bouvier are identical. The inference is obvious.

There remains the question of priority in nomenclature. Spencer's paper is dated March 1909, although read in September 1908. Bouvier's paper is dated 1909, but no month of issue is given. In answer to a request for the exact date, Dr. Michaelsen writes that the paper was published in December 1909. Spencer's description has therefore several months' priority. There is, then, only one species of *Peripatus* so far discovered in the region near Perth, and that is *Peripatoides gilesii* Spencer. The name *Peripatoides woodwardi* must be rescinded.

It was hoped that specimens of *Peripatoides occidentalis* would be collected at Bridgetown for purposes of comparison, but, owing to heavy rains this year, that district was flooded at the time when the expedition had been arranged.



Huth sc. et imp.



14.



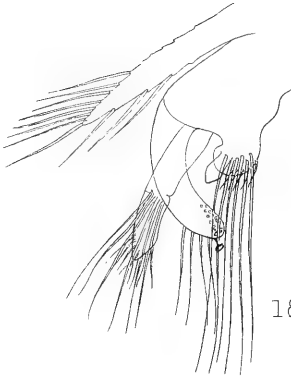
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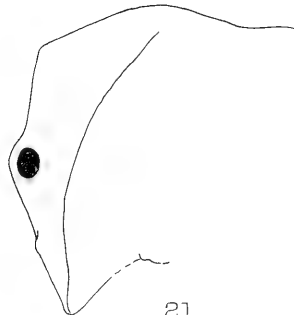
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20.



19.



21.

Huth sc. et imp.

20. Fauna of Western Australia.—II. The Phyllopoda of Western Australia. By W. J. DAKIN, D.Sc., F.L.S., F.Z.S., Professor of Biology in the University of Western Australia.

[Received January 12, 1914: Read March 17, 1914.]

(Plates I. & II.*)

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Introduction.

The Phyllopoda of Western Australia have, up to date, been known only from one or two specimens collected in the Murchison District and examined by Sayce†; from one or two specimens worked at by Sars‡; and from those specimens collected by the Hamburg Expedition to the South-West in 1905§. The records are anything but extensive. Australia (as Wolf himself states in his report upon these crustacea) is a country where the conditions are particularly favourable for the presence of Phyllopoda.

Western Australia is exceptionally well suited for these animals, and they are to be found everywhere in large numbers after the rainy season has commenced. They occur in small rock-pools far inland, in swampy places with perhaps two or three inches of water lying in depressions in fields, in temporary lakes on the goldfields, and even in depressions filled with water—extended cart ruts—on frequently used country roads.

Future investigation should bring to light many more forms, for the area to be explored is indeed great. A glance at the following table will serve to indicate the species discovered up to date and also their distribution.

Out of the 33 to 35 Phyllopods known from the Australian Continent previous to this paper, only *two* of those species found on the eastern side of the island were known to occur in Western Australia. Only nine species altogether had been recorded from Western Australia, and seven of these were peculiar to the State.

I have been able to add to the list a number of new forms,

* For explanation of the Plates see p. 204.

† Sayce, Proc. Royal Soc. Victoria, New Series, vol. xv. 1902.

‡ Sars, Arch. for Math. og Naturvid. Christiania, xix.

§ Wolf, Phyllopoda: 'Die Fauna Südwest-Australiens,' Band iii. (Jena, 1910-1911).

Districts where recorded.

	West Australia.	South Australia.	New South Wales.	Victoria.	Queensland.	Tasmania.
BRANCHIPODIDÆ.						
<i>Artemisia australis</i> (Sayce) .....	.....	Coastal region.	.....	.....	.....	.....
" <i>westraliensis</i> (Sayce)	Murchison.	.....	.....	.....	.....	.....
" <i>proxima</i> ? (King) .....	.....	Near Lake	Near Sydney.	.....	.....	.....
<i>Parartemia zietziانا</i> Sayce .....	.....	Alexandrina.	.....	.....	.....	.....
<i>Branchinella australiensis</i> (Richters)	.....	South Coast & Cent. Australia.	.....	Northern & Southern.	Inland area.	.....
" " var. <i>occiden-</i>	.....	.....	.....	.....	.....	.....
" " <i>talis</i> , nov.	Lake Violet.	.....	.....	.....	.....	.....
" <i>eyrensis</i> (Sayce)	Kalgoorlie.	Cent. Australia.	.....	.....	.....	.....
" <i>longirostris</i> (Wolf)	Boorabbin & Burracoppin.	.....	.....	.....	.....	.....
" <i>norhamensis</i> , sp. n.	Northam.	.....	.....	.....	.....	.....
<i>Streptocephalus archeri</i> ? Sars .....	.....	.....	.....	.....	Rockhampton.	.....
TRIOPSIDÆ.						
<i>Triops (Apus) australiensis</i> (Spencer & Hall)	West Australia.	South Australia.	Inland area.	Northern area.	.....	.....
" <i>gracilis</i> Wolf	Kalgoorlie.	.....	.....	.....	.....	.....
" <i>strenuus</i> Wolf	Tammin.	Central.	.....	.....	.....	.....
<i>Lepidurus viridis</i> Baird .....	.....	Southern part.	Inland and Coastal.	Northern & Southern.	.....	Tasmania.
" " var. <i>elongatus</i> Wolf	Broome Hill & Northam.	.....	.....	.....	.....	.....
" " var. <i>setosus</i> Wolf .....	.....	South Australia.	.....	Victoria.	.....	.....

LIMNADIIDÆ.

<i>Eulimnadia dahl</i> Sars .....	.....	Port Darwin & Cent. Australia. ....	.....	Near Botany Bay & near Sydney. N. S. W. ?	.....
" <i>sordida</i> King .....	.....	.....	.....	.....	.....
" <i>rivulensis</i> Brady	Busselton.	Rivoli Bay, Cent. Australia. ....	.....	Southern area.	.....
" <i>cygnorum</i> , sp. n.	Near Perth.	.....	.....	.....	.....
" <i>feriensis</i> , sp. n.	Northam.	.....	.....	.....	.....
" <i>victoriensis</i> Sayce .....	.....	.....	.....	.....	.....
" <i>badia</i> Wolf	Boorabbin & Burracoppin.	.....	.....	.....	.....
<i>Paralimnadia stanleyana</i> King .....	.....	.....	.....	Near Sydney.	.....
<i>Limnadopsis birokii</i> (Baird) .....	.....	Cent. Australia.	.....	N. S. W.	.....
" <i>squirei</i> ? Spencer & Hall .....	.....	Cent. Australia.	.....	.....	.....
" <i>tatei</i> Spencer & Hall .....	.....	Port Darwin.	.....	.....	.....
" <i>brunneus</i> Spencer & Hall .....	.....	Southern area & Central.	.....	N. S. W.	.....
<i>Cyzicus</i> (<i>Estheria</i>) <i>packardii</i> (Brady) .....	.....	.....	.....	Northern & Southern areas.	.....
" <i>ellipticus</i> (Sars)	Near Roebuck Bay.	.....	.....	.....	.....
" <i>sarsii</i> (Sayce)	Murchison.	.....	.....	.....	.....
" <i>lutraria</i> (Brady) .....	.....	Cent. Australia.	.....	.....	.....
" <i>riga</i> , sp. n.	Boulder City.	Cent. Australia.	.....	.....	.....
" <i>dictyon</i> (Spencer & Hall) ? .....	.....	Cent. Australia.	.....	.....	.....
<i>Cyclestheria histopi</i> (Baird) .....	.....	.....	.....	.....	Rockhampton.
LYNCEIDÆ.					
<i>Lynceus macleayana</i> (King) .....	.....	.....	.....	Near Sydney.	Northern & Southern.
" <i>tatei</i> (Brady)	Busselton.	Rivoli Bay.	.....	N. S. W.	Southern area.
" <i>eremia</i> (Spencer & Hall) .....	.....	Cooper's Creek.	.....	.....	.....

and, what is perhaps more interesting, to show that some of the species already known from the other States of the Commonwealth occur also in Western Australia. The Western State is, therefore, not so distinct from the other regions as the earlier investigations might lead one to believe. There are now twelve species or varieties which are known only from the West, and there is no doubt that further investigation will reveal several more new species and very probably a much wider distribution for the species already known. The new records are from specimens collected by Professor Woolnough, Mr. Alexander, and the author. Two of the species discovered by the Hamburg Expedition have been met with again.

EUPHYLLOPODA.

ANOSTRACA.

Family BRANCHIOPODIDÆ.

Genus ARTEMISIA.

ARTEMISIA WESTRALIENSIS (Sayce)*.

This species is the only *Artemia* known to occur in Western Australia. It was collected in Lake Aurean in the Murchison District in 1896, but no male specimens have as yet been obtained.

Genus BRANCHINELLA Sayce, 1903.

This genus was instituted by Sayce to receive two Branchipods which, though agreeing with *Branchipus* in very many ways, differed in the male claspers being without any accessory branch or spine, the second antennæ of the female being long and ribbon-like, and the penis of the male possessing certain peculiar characters.

Since the genus was founded, the Hamburg Expedition discovered one of the two species in Western Australia. This was previously known only from Central Australia. The expedition's collection also included a new species. Up to date no species of *Branchipus* has been met with in Australia. We have rediscovered the species of the German expedition, extended the distribution of an Eastern form, which, however, occurs here in the form of a variety, and added still another species to the list.

BRANCHINELLA AUSTRALIENSIS (Richters).

Variety *occidentalis*, nov. (Pl. I. figs. 1-5.)

The species *Branchinella australiensis*, a large and stout Branchipod, was first described by Richters † from specimens from

* [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature (Proc. 7th Int. Cong. Boston 1907, p. 44 (1912)).—EDITOR.]

† Richters, Journ. de Muséum Godeffroy, xii., 1876.

Queensland. The description was, however, overlooked until re-discovered by Hall and Sayce. The latter found the species to be quite common near Melbourne. It occurs in Central Australia, the coastal area of Southern Australia, and in North and South Victoria.

In fact, its known distribution was pretty general, and only Western Australia seemed to be without it.

Two large Branchipods have been investigated in the course of this work, both unfortunately of the same sex. They agree in very many points with the description given by Sayce.

Description of male (fig. 1).—Body stout; trunk of equal length to tail. Branchial feet with large covering plates. The six endites are almost the same as in the figure given by Sayce*. The position of the flabellum is different, and the relative size of covering plate (proximal exite) and flabellum is considerably different. Claspers large and powerful (fig. 3), basal joint with inner surface clothed with minute teeth, the second joint longer in proportion to the first than in typical *Branchinella australiensis*. The inner surface of the clasper bears curious transverse overlapping shelves (fig. 4). These have the appearance of transverse ridges. They end abruptly along a regular line at each side. Frontal appendages invisible in specimens. First antennæ remarkably long, filiform, and about three times the length of the second antennæ (fig. 2), and quite different from those figured by Sayce for *Branchinella australiensis*. Caudal rami no longer than the last four segments of tail. Sheath of penis not notched (penes were not everted). Length inclusive of caudal rami 35 mm.

The resemblance to *Branchinella australiensis* seems to be great enough to consider this as a variety of form. The outstanding difference is in the first antennæ and the reduction of the frontal appendages.

Locality. Lake Violet (near the centre of Western Australia).

BRANCHINELLA LONGIROSTRIS (Wolf).

This characteristic form was first discovered in the course of the Hamburg Expedition, and had only been recorded this once from Australia. It has now been collected again (seven years later) from similar situations in the district where it was originally found.

Both males and females occur. The characteristic huge frontal appendage of the male cannot possibly be mistaken.

For complete diagrams see Wolf †.

Locality. Small rain-water ponds in depressions in rocks at Burracoppin. They occurred with the same companions found by the Hamburg Expedition, viz. specimens of *Eulimnadia badia*.

* Procs. R. Soc. Victoria, n. s. xv. pl. xxx.

† Wolf, Phyllopoda: 'Die Fauna Südwest-Australiens,' Band iii. (Jena, 1910-1911).

BRANCHINELLA NORTHAMENSIS, sp. n. (Pl. I. figs. 6-8.)

Description of female.—No males of this species have been discovered. The female is an undoubted *Branchinella*. In general appearance and size the specimens resemble the females of *Branchinella longirostris*, and are much smaller and more delicate than *Branchinella australiensis*. The living animal is colourless and semi-transparent. Eyes very prominent. The head and limb-bearing region of the trunk are together much longer than the limbless posterior region (termed the tail by Sayce).

1st antennæ filiform and about $1\frac{1}{2}$ times the length of the second antennæ (see fig. 8).

2nd antennæ more or less ribbon-like but not flattened very much. They decrease but little in width until they terminate in a rounded end with a sharp point which is situated abruptly at the apex.

The ovisac (fig. 7) is very slender, without lateral expansions proximally, and extends posteriorly to the middle of the 4th limbless segment (tail-segment). It possesses the characteristic ridge on the ventral surface.

The caudal rami are well developed, provided with strong setæ and equal in length to the last four segments of the body (fig. 6). Length 13 mm.

This species is distinct from *Branchinella australiensis* in

- (1) General character, size, and shape.
- (2) Form of appendages.
- (3) Antennæ.

It is distinct from *Branchinella eyrensis* by

- (1) Frontal appendage.
- (2) Size and general form.
- (3) Ovisac.

It is distinct from *Branchinella longirostris* by

- (1) 2nd antennæ.
- (2) Ovisac.

BRANCHINELLA EYRENSIS (Sayce).

This species was recorded by the Hamburg Expedition from Kalgoorlie on the goldfields.

Only two specimens were obtained, and they were in bad condition. No other specimens have so far been met with. For diagnosis see Sayce.

CONCHOSTRACA.

Family LIMNADIIDÆ.

Genus EULIMNADIA.

Only one species had been found hitherto in Western Australia, and that by the Hamburg Expedition in 1905. This was recognised as a new species by Wolf, so that up to the date of

the present report, none of the *Eulimnadia* occurring elsewhere in Australia had been found in the West.

We have rediscovered Wolf's species and can confirm his description of the same.

In addition, we have two new species and the first record of an Eastern form.

EULIMNADIA CYGNORUM, sp. n. (Pl. I. figs. 9-13.)

Shell compressed, thin, without trace of umbones (fig. 11).

Lines of growth with great difficulty discernible and only about three visible.

Dorsal line evenly arched, with highest point anterior to middle. General shape more resembling *Eulimnadia rivolensis*, but with a more obtuse posterior end.

Head with rostral expansion in male, moderately long and bluntly pointed. In female much shorter and not acute (figs. 9 & 11).

Legs—not possible to make out exact number, but apparently not exceeding 18 pairs in female.

Male with anterior legs subchelate—developed as claspers (fig. 13). The hooked termination, which is covered with small pits, carries a prominent stalked disc. The subapical appendage is extremely long in this species, much longer than in either *Eulimnadia badia* Wolf or *Eulimnadia rivolensis* Brady. There are two distinct segments, but it is possible that the last extremely long one is in reality two, as in *Eulimnadia rivolensis*. In any case the segmentation is very much less marked than in this latter species, specimens of which have been carefully compared with it. The appendage is longer than in any other Australian *Eulimnadia*. There is an angular prominence above the terminal hook, just as in *Eulimnadia badia* and *Eulimnadia rivolensis*. Whilst, however, it is not so large as in the former species, it stands away from the claw much more than it does in *Eulimnadia rivolensis*.

The caudal claws (fig. 12) are slightly bent upwards, the proximal part very slightly so. The distal end is provided with a row of sawlike minute prickles. The proximal half bears a few feathered setæ.

The lateral plates of the tail are almost straight and bear about 20 acute denticles. The most posterior one is large and perfectly straight, differing in this respect from *Eulimnadia rivolensis*. All the spines are provided with minute sawlike points along the sides.

This species is characterised by

- (1) Shell and lines of growth.
- (2) Anterior legs of male.
- (3) Rostrum.
- (4) Caudal claws and tail.

Specimens, both male and female, obtained from Cannington, near the Swan River.

EULIMNADIA FERIENSIS, sp. n. (Pl. II. figs. 14-18.)

A considerable number of specimens, both of males and of females, was obtained from a little patch of flooded bushland at Northam. In the same pool occurred *Branchinella* and swarms of tadpoles.

Shell (fig. 14) very thin and pellucid. Of same appearance in both sexes. No lines of growth visible. In lateral view almost equilateral. The dorsal margin slightly vaulted, the greatest height being only a shade in front of the middle. Shell compressed.

Head (figs. 15 & 16). No great difference between the sexes. Rostrum short and bluntly rounded.

Legs 16-18 pairs. Anterior pairs in males subchelate (fig. 18); not particularly robust. Armed with numerous setæ. No process on inner side of band above thumblike projection (cf. figure of *Eulimnadia cygnorum*).

Tail with caudal claws (fig. 17). The proximal part of the claws bears a few feathered setæ. The region, not quite half of the total length, bears a well-marked sawlike row of minute spines. The two lateral plates terminate in two long processes, armed with minute denticles, and the upper edges of the plates in the female bear about 16 to 18 spines of unequal length. In the female there is also a tendency for the most posterior of the spines to be arranged in groups of 4 or 5, the size of spines in each group diminishing anteriorly (fig. 17). There are only about 12-14 spines in the male. All the spines are armed with minute denticles.

Size. Length of specimens 5.5 mm.

EULIMNADIA RIVOLENSIS Brady.

This species was described originally by Brady in 1886. Up to this present report it was known from Southern Australia, Central Australia, and Southern Victoria, with the possibility of an extension into New South Wales. Now it has been found in Western Australia, and not where it might have been expected, inland on the goldfields, but down on the South-West Coast in small ponds near Busselton. Several specimens were obtained there by Mr. Alexander, and the collection includes both males and females. There is nothing further to add to the descriptions previously given by Brady, Spencer and Hall,* and Sayce. This was the only *Eulimnadia* obtained by the expedition to Central Australia. This discovery of its occurrence in Western Australia is particularly interesting, because it is the first *Eulimnadia* of the East and Central States to be recorded from the West.

* Spencer and Hall, Reports Horn Expedition to Central Australia, Part II.

EULIMNADIA BADIA Wolf.

This species was the only *Eulimnadia* known from Western Australia before this report. It was discovered by the Hamburg Expedition in pools together with *Branchinella longirostris*. As mentioned in discussing that species, *Eulimnadia badia* has again turned up with its fellow companion. I can confirm the description of Wolf, but must make a slight alteration, or rather an addition, to his diagnosis of the species. The specimens were collected by Professor Woolnough. They are the largest and most robust of our *Eulimnadia*. Fortunately I have been able to compare these specimens with the type in the Hamburg Collection. Wolf remarks that never more than five lines of growth can be observed on the shells. I have recognised six and even seven on some specimens. Another slight point of difference is that the shell-gland is stated to occur always inside the first line of growth. This is frequently the case but not always, and often extends over the first line. In Wolf's drawing it is indicated well inside the lines of growth. One other point is that the head in the region of the eye does not protrude in such an angular manner as figured and described by Wolf. There is absolutely no doubt about the identity of the two sets of specimens. The characteristic features are all obvious, and it is well to emphasise these slight variations perhaps due to age or the season, especially since they have been touched upon and figured as of some little diagnostic value.

Both males and females occurred in rock-pools near Burracoppin, not very far from Boorabbin, where originally discovered.

Genus CYZICUS.

CYZICUS (ESTHERIA) RUFA, sp. n. (Pl. II. figs. 19-21.)

Five species have been recorded from Australia, and out of this number two were from Western Australia. These were determined by G. O. Sars and Sayce respectively. No specimens were met with by the German Expedition. The species of Sars is *Cyzicus elliptica*, and that of Sayce *Cyzicus sarsii*.

The new species, *Cyzicus rufa*, was collected in pools at Lakeside, Boulder City, by Mr. Alexander. Two individuals were at my disposal, but unfortunately both were females.

Characters. Shell, seen laterally, of a rather quadrangular form (fig. 19), both ends being rather too obtusely rounded to give the impression of an ellipse. Anterior-posterior length rather great for the dorso-ventral depth, and much longer than that of any of the other Australian species. Umbone prominent and situated much nearer the anterior end (about one-fourth the total antero-posterior diameter from the anterior end of the shell). The ventral margin of the shell is almost straight for some distance. Both ends are evenly rounded, and the axis of greatest length lies midway between the dorsal and ventral margins of the shell. Lines of growth about fourteen, with setæ. The sculpture of the

shell is reticulate and irregular. The valves are red-brown in colour and of firm consistency.

Rostrum (fig. 21) pointed and moderately long.

The number of legs is less than 20 pairs.

Tail of usual shape (fig. 20). The caudal plates have their upper margins almost straight. Each plate bears about five equal denticles and some smaller ones.

The caudal claws bear feathered setæ on the proximal half.

Eggs spherical.

Size. Length of adult female, 8.5 mm.

The species *Cyzicus rufa* differs from *Cyzicus lutraria* in

- (1) Shape of shell—straight ventral margin, convexity of anterior end. No compression behind middle.
- (2) Caudal plates not concave dorsally.
- (3) Rostrum of female moderately long.
- (4) Much smaller number of appendages.

The species differs from *Cyzicus elliptica* in

- (1) Shell—ridges and shape generally.
- (2) Tail.
- (3) Size.
- (4) Number of appendages.

The species differs from *Cyzicus sarsii* in

- (1) Shape of head.
- (2) Shape of shell and number of ridges.
- (3) Caudal plates.

The species differs from *Cyzicus packardii* in

- (1) Shell—general shape and lines of growth.
- (2) Shell sculpture.
- (3) Caudal plates.

Cyzicus dictyon (Spencer & Hall) seems to be synonymous with *Estheria lutraria*.

There is a possibility that this might be the female of *Cyzicus sarsii*, a species founded by Sayce on one example, a male. The differences in the shell, etc., are so great that the author considers it more probably a new species.

Family LYNCEIDÆ.

Genus LYNCEUS.

Three species of the genus *Lynceus* have been recorded from Australia, and of these none is supposed to occur in Western Australia.

The record that I have to note therefore shows still further that the supposed absence of East Australian species of Phyllopoda

from the Western State is probably due to the small number of collections that have been made.

LYNCEUS TATEI (Brady).

Several specimens were collected in pools at Busselton, South-West Australia. They agree in almost all respects with the description by Sars and the figures by Brady.

There is a slight difference in the shape of the rostrum, but this is so small that it seems hardly sound to make a new variety out of the specimens at my disposal. The collection included both males and females. The size was much smaller than the figure given by Sayce. Specimens varied between 2.5 mm. and 3.75 mm.

Lynceus tatei is now known from Victoria, New South Wales, South Australia, and Western Australia.

Family TRIOPSIDÆ (APODIDÆ).

Genera APUS and LEPIDURUS.

The family Triopsidæ contains but two genera, *Apus* (*Triops*) and *Lepidurus*. Both genera occur in Australia, and as a result of the Hamburg Expedition both were recorded from Western Australia. *Apus* itself has been recorded previously from Western Australia. Both genera appear to be pretty common in pools scattered about the State, and although specimens have only been obtained from one or two places, there is evidence that their occurrence is by no means restricted to these spots.

Genus LEPIDURUS.

Wolf, in his paper on the Phyllopoda of the Hamburg Expedition, remarks on the great difficulty in diagnosing species of this genus. The number of the segments which bear no appendages varies in one and the same species, and in no form is the number eight exceeded. Large numbers of specimens are required before one can feel certain of any systematic work. The result is that five species recorded from Australia are considered to be all identical—the species being then *Lepidurus viridis* Baird. Wolf found, however, that there were some essential differences in the specimens from different localities, which he had received for examination, and as a consequence divided his examples into two new varieties. These are *Lepidurus viridis* Baird, var. *elongatus* Wolf, and *Lepidurus viridis* Baird, var. *setosus* Wolf.

I have met with specimens which are evidently *Lepidurus viridis* var. *elongatus*, and from quite a new locality, namely Northam.

LEPIDURUS VIRIDIS Baird, var. *ELONGATUS* Wolf.

Specimens occur regularly every year about July and August in very shallow, muddy pools on a road at Northam.

The characteristic carapace covering all the segments of the body and only allowing a glimpse of the caudal rami enables one to recognise the similarity to Wolf's specimens.

The number of segments not bearing legs is as usual, five. The length of my specimens averaged about 28 mm. without the caudal appendages, and these brought the total length to 53 mm. This size is greater than that of the largest of Wolf's specimens.

LEPIDURUS VIRIDIS.

A large number of specimens of *Lepidurus* has been obtained from waters at Tammin, Western Australia. These individuals are certainly not Wolf's variety *Lepidurus viridis* var. *elongatus*, and still more certainly not his variety *setosus*. They may be described as follows:—The large examples average about 20 mm. for length of carapace, with a total length of 40 mm. counting the long anal furca.

The carapace is broadly rounded in front and somewhat considerably vaulted behind, with a prominent keel down the middle line. The posterior notch in the carapace is practically semicircular.

The long axes of the eyes run at an angle to each other to meet anteriorly. The anterior and posterior margins of the crescentic eyes are of similar shape and extent.

The "Nackenorgan" projecting between the two eyes and slightly posterior is circular in shape.

It seems undesirable to name these specimens anything but the simple *Lepidurus viridis*. From the difficulty of recognising varieties it would appear that a comparative study of the genus is required. This could only be carried out successfully with a very large collection of individuals from many localities in different parts of the world.

EXPLANATION OF THE PLATES.

PLATE I.

Branchinella australiensis, var. *occidentalis*, nov.

- Fig. 1. Male specimen. $\times 1.5$.
2. Head and appendages of male. $\times 3.5$.
3. Antenna or "clasper" of male. $\times 5$.
4. Surface of antenna considerably enlarged.
5. 4th trunk-limb of male. $\times 6$.

Branchinella northamensis, sp. n.

- Fig. 6. Posterior segments and caudal rami. $\times 10$.
7. Genital segments bearing ovary. $\times 10$.
8. Head and appendages of female. $\times 8$.

Eulimnadia cygnorum.

- Fig. 9. Head of male. $\times 20$.
 10. Shell. $\times 4$.
 11. Head of female. $\times 18$.
 12. Tail and caudal claws. $\times 12$.
 13. 1st trunk-limb of male. $\times 40$.

PLATE II.

Eulimnadia feriensis, sp. n.

- Fig. 14. Shell. $\times 5$.
 15. Head of male. $\times 20$.
 16. Head of female. $\times 20$.
 17. Tail and caudal claws of female. $\times 10$.
 18. 1st trunk-limb of male. $\times 50$.

Cyzicus (Estheria) rufa, sp. n.

- Fig. 19. Shell. $\times 3.5$.
 20. Tail. $\times 10$.
 21. Head of female. $\times 20$.

21. Notes on a Collection of East African Mammals presented to the British Museum by Mr. G. P. Cosens. By GUY DOLLMAN*.

[Received February 12, 1914: Read April 7, 1914.]

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I have the pleasure of furnishing a report on the Mammals obtained by Mr. Willoughby P. Lowe during the recent East African Expedition organized by Mr. G. P. Cosens. The entire collection, some two hundred specimens in all, has been presented by Mr. Cosens to the British Museum.

In working out this collection I have found it necessary to describe six new forms†, the most interesting of which, the new Gerbil (*Gerbillus cosensi*), I have named in honour of the generous donor. Another interesting novelty, *Taterillus lowei*, I have called after Mr. Willoughby Lowe, the collector.

The East African mammals were obtained in the Naivasha and Nyanza Provinces. The route taken was from Kijabe to Mt. Suswa, where the first collecting was done, then westwards across the Loita Plains and Lemek Valley to the Amala or Mara River. After ten days' collecting along the Amala River the expedition turned south towards the Anglo-German Boundary and then eastwards, via Leganisho, to Lengototo, the Narossura and Southern Guaso Nyiro Rivers. Further collecting was done along the southern Guaso Nyiro, and the party then proceeded northwards as far as the Mau Escarpment, returning to the railway at Naivasha.

The Uganda Expedition started from Baringo in December, 1912, and travelled in a north-easterly direction across the Kerio and Wei Wei Rivers, and then along the Turkwel as far north as Ngamatak. Turning westwards the party reached the Kozibir Hills on January 22nd, 1913, and Mt. Maroto on January 28th. Proceeding in an easterly direction, via the Nakwai Hills and Lobar Mountains, Kamchuru was reached on February 9th, and here the greater part of the collecting was done. Other

* Communicated by OLDFIELD THOMAS, F.R.S., F.Z.S., and published by permission of the Trustees of the British Museum.

† [The complete account of the new forms described in this communication appears here, but since the names and preliminary diagnoses were published in the 'Abstract,' No. 131, 1914, these species are distinguished by the names being underlined.—EDITOR.]

mammals were obtained on the journey from Kamchuru, via Pader and Falabek, to Nimule.

In the following list the East African and Uganda Collections are not treated of separately, as it seems more convenient, the two areas not being faunistically distinct, to consider the collections together.

1. *PAPIO FURAX* Elliot.

♂. 73. 12 miles east of the Amala River, British East Africa.

♂. 70. Amala River.

♂. 74. East of Amala River.

The skulls of the two adult males (Nos. 73 and 70) are surprisingly different in general structure, especially as regards the nasal regions and dental characters. The difference may be of specific value, as it is not rare to find two nearly allied species of Baboons existing in the same locality; with such variable animals, however, I do not feel justified in dealing with this question until further material is available for examination.

2. *CERCOPITHECUS PYGERYTHRUS CENTRALIS* Neum.

♂. 75. 12 miles east of Amala River.

♂. 153. Wei Wei River, Rift Valley.

♀. 127. 20 miles south of Baringo.

♂. 137. 30 miles N.W. of Baringo.

3. *EPOMOPHORUS MINOR* Dobs.

♀. 111. Southern Guaso Nyiro.

4. *EPOMOPHORUS ANURUS* Heuglin.

♂. 186. Mt. Maroto, Uganda.

5. *LAVIA FRONS FRONS* E. Geoff.

♀. 40. Amala River.

♀. 134, 138. 30 miles N.W. of Baringo.

♀. 192. Bakora, Uganda.

♂. Pader, Uganda.

♂. 172; ♀. 171. Kozibiri River, Uganda.

♂. 184, 188. Mt. Maroto, Uganda.

6. *PIPISTRELLUS DESERTI* Thos.

♂. 185. Mt. Maroto, Uganda.

♂. 175. Kozibiri River, Uganda.

♂. 151, 152. Wei Wei River, B.E.A.

7. *SCOTOPHILUS NIGRITA* Schreb.

♂. 140. 30 miles N.W. of Baringo.

179 (in spirit). Mt. Maroto, Uganda.

8. *SCOTEINUS SCHLIEFENI* Pet.

♀. 169. Kozibiri River.

♂. 133. 30 miles N.W. of Baringo.

♂. 148, 149, 150, 154. Wei Wei River.

♂. 158, 159, 166, 167. Turkwel River.

9. *TAPHOZOUS MAURITIANUS* E. Geoff.

♀. 168. Turkwel River.

10. *ELEPHANTULUS DUNDASI* Dollm.

♂. 145. 12 miles N.W. of the Kerio River, B.E.A.

The exact locality where this specimen was obtained is not more than 75 miles N.W. of Baringo, the type locality of the species.

11. *NASILIO BRACHYRHYNCHUS ALBIVENTER* Osg.

♂. 90; ♀. 86. Lengototo, B.E.A.

12. *CROCIDURA MONAX* Thos.

♀. 55. Amala River.

13. *CROCIDURA JACKSONI* Thos.

♂. 50; ♀. 63, 66. Amala River.

♀. 99. Narossura River.

89. Lengototo.

14. *FELIS CAPENSIS HINDEI* Wrought.

♂. 46. Amala River.

A fine example of the melanistic phase so frequently met with in these Serval Cats.

15. *GENETTA ERLANGERI* Matsch.

♂. 19. Southern Guaso Nyiro.

♀. 33. Amala River.

♂. 32; ♀. 31. Lemek Valley.

♀. 80, 81. East of Leganisho.

16. *ICTONYX CAPENSIS ALBESCENS* Heller.

♂. 18. Southern Guaso Nyiro.

The type locality of *Ictonyx c. albescens* is given by Heller as Mt. Lololokwi, Northern Guaso Nyiro, a long way north of the Southern Guaso Nyiro; this author also records specimens of *albescens* from Nairobi, and it seems probable that this race extends over a very large part of the Protectorate.

17. *MUNGOS ALBICAUDA* G. Cuv.

♀. 37. Amala River.

18. *MUNGOS SANGUINEUS IBEÆ* Wrought.

♂. 102. Narossura River.

19. *HELOGALE PERCIVALI* Thos.

♂. 166. Turkwel River.

The type of *Helogale percivali* was obtained by Mr. Percival in the Orr Valley, Mt. Nyiro. This specimen from the Turkwel River agrees with the unique type in all respects.

20. *HELOGALE UNDULATA RUFULA* Thos.

♀. 110. Southern Guaso Nyiro.

21. *HELOGALE VICTORINA* Thos.

♂. 43, 59, 62; ♀. 42, 44, 61. Amala River.

22. *CANIS LATERALIS* Sclater.

♂. 69. Amala River.

♀. 176. Kozibiri River, Uganda.

23. *HELIOSCIURUS MULTICOLOR ELEGANS* Thos.

♀. 142. Suk Plains, Kerio River.

♀. 162. Doroto District, Turkwel River.

♂. 181, 182. Mt. Maroto, N.E. Karamoja, Central Province, Uganda.

♂. 198. Nakwai Hills, N. of Lake Kirkpatrick, Central Province, Uganda.

♂. 148. N.W. of Suk Plains, on the Wei Wei River.

This series is rather variable in colour, possibly due to bleaching. The type locality of *elegans* is Mt. Elgon, so that this race would appear to extend northwards over a very large area.

24. *PARAXERUS OCHRACEUS ELECTUS* Thos.

♂. 155. Ngaboro, Wei Wei River, Rift Valley.

♂. 157. Ngeronomi, Turkwel River.

♀. 156. Ngabotok, Kilebor, Turkwel River.

These three Squirrels are quite similar to the typical specimens of *electus*, described by Thomas from Elgoyu, British East Africa. Mr. Kemp obtained a series of this race on the Laikipia Plateau; it is worthy of note that all these specimens are exactly like the type, there apparently being no colour variation at all.

25. *XERUS DABAGALA DORSALIS* Dollm.

♂. 131, 132. Baringo.

♂. 126. 40 miles N.W. of Nakuru.

♂. 143; ♀. 144. Suk Plains, 12 miles N.W. of Kerio River, B.E.A.

Xerus dabagala dorsalis was founded on a series of specimens collected by Mr. Kemp at Baringo, so that Nos. 131 and 132 are topotypes, and agree very closely with Mr. Kemp's specimens.

26. *GRAPHIURUS BROCKMANI INTERNUS* Dollm.

♀. 100. Narossura River.

♀. 105, 109. Southern Guaso Nyiro.

These Dormice do not appear to differ from the specimens collected by Mr. Blayney Percival and Mr. Robin Kemp on the Northern Guaso Nyiro, the type locality of this race.

27. *DIPODILLUS HARWOODI* Thos.

♂. 118. Southern Guaso Nyiro.

This diminutive Gerbil is evidently widely distributed over the southern portion of British East Africa. The type locality of the species is Naivasha, but it would appear to extend much further south than many Naivasha mammals; Dr. Bayer obtained a *Dipodillus harwoodi* from as far south as the Tsavo River. This specimen, which is in the collection of the Congo Museum, Tervueren, I have recently had an opportunity of examining, and there would appear to be no doubt that it represents the Naivasha species.

28. *GERBILLUS COSENSI* Dollm.

Abstract P. Z. S. 1914, p. 25. (April 14.)

♂. 170. Kozibiri River, Ngamatak, Turkwel River. Altitude 1800 feet.

Allied to *Gerbillus dunni* Thos., the Somali species, but readily distinguished by its duller colour and smaller size.

General proportions rather less than in *dunni*, the hind foot measuring only 25 mm. in length.

General colour of dorsal surface pale buff mixed with slate-grey, the grey tint most obvious on the shoulders and down the middle of the back; flanks brownish buff, near "warm buff" (Ridgway, 1912). Head similar in colour to back, the slate-grey bases of the hairs showing through the yellowish-buff tips. Sides of face white; pale greyish-buff markings extending from below the eyes to the ears. Backs of hands and feet white. Entire ventral surface pure white. Dorsal surface of tail much darker than in *dunni*, above dirty brown, below white.

The skull of this unique specimen is unfortunately badly broken, all the region posterior to the frontals and palate being missing. Compared with the skull of the Somali species the general structure would appear to be very much the same, but rather smaller throughout.

Dimensions of the type (measured in the flesh):—

Head and body 78 mm.; tail 129; hind foot 25; ear 14.

Skull (posterior part of skull broken): length from frontoparietal suture to tip of nasals 19.5 mm.; length of nasals 10; greatest breadth across nasals 2.4; interorbital constriction 5; length of anterior palatal foramen 4; length of posterior palatal cavities 2.2; alveolar length of upper molar series 4.

Type. Adult male. B.M. No. 13.10.18.64. Collected January 17th, 1913.

The donor and collector are to be congratulated on the discovery of the genus *Gerbillus* on the Turkwel River. The Somali species would appear to be the nearest ally of this new form, though doubtless further collecting will bring to light several other races of East African *Gerbillus*.

29. *TATERILLUS EMINI* Thos.

♂. 202, 203, 204, 206, 217, 218, 219; ♀. 205, 214, 215. Kamchuru, Lopor, Uganda.

♂. 225. Falabek, 45 miles east of Nimule.

The general colour of this series is very much as in the type, a specimen collected by Emin Pasha at Wadelai. The young specimen are all rather darker than the adults, especially on the back and hind quarters.

30. *TATERILLUS LOWEI* Dollm.

Abstract P. Z. S. 1914, p. 25. (April 14.)

♂. 165. 10 miles west of the Ngamatak Hills, Turkwel River. Altitude 1800 feet.

A very pale coloured species allied to *Taterillus nubilus* Dollm.

In general proportions this Gerbil is quite similar to *nubilus* and the allied forms.

Colour of dorsal surface pale dirty yellow, a mixture of "vinaaceous-buff" and "warm-buff" (Ridgway, 1912); the central portion of the back is rather darker, owing to the dark hair-tips being more developed. Flanks purer and yellower in colour. Head same colour as back; sides of face as in *nubilus*, but rather paler. Backs of hands and feet creamy white. Entire ventral surface pure white. Tail much as in *nubilus* but paler, and with the cream-white ventral surface more sharply marked off from the dull upper surface.

Skull very like that of *nubilus*, slightly smaller throughout.

Dimensions of the type (measured in the flesh):—

Head and body 107 mm.; tail 160; hind foot 28; ear 18.

Skull: greatest length 34.3 mm.; basal length 28.3; zygomatic breadth 16.5; length of nasals 13.5; width of brain-case (across squamosal region) 14.5; interorbital constriction 6; length of anterior palatal foramina 5.8; length of posterior palatal foramina 3.5; alveolar length of upper molar series 4.8.

Type. Adult male. B.M. No. 13.10.18.66. Collected on January 15th, 1913.

This species is the palest of all the East African forms, the only members of the genus at all similar in colour being the West African species *Taterillus lacustris* and *Taterillus nigerica*.

31. *TATERA NIGRICAUDA* Pet.

♂. 107; ♀. 113, 114. Southern Guaso Nyiro.

32. *DENDROMUS LINEATUS* Heller.

♂. 208, 209. Kamchuru, Lobor.

These two specimens show the same variation as regards the distinctness of the median stripe as is mentioned by Heller in his description of the species, the type locality of which is Lado.

33. *DENDROMUS ACRÆUS* Wrought.

♂. 45. Amala River.

34. *DENDROMUS NIGRIFRONS* True.

♀. 60. Amala River.

35. *MUS BELLUS* Thos.

♀. 124. Lake Naivasha.

36. *MUS BELLUS GONDOKORÆ* Heller.

♀. 183. Mt. Maroto, Maroto Stream, Central Province, Uganda.

37. *MUS MUSCULOIDES EMESI* Heller.

♂. 227. Falabek, east of Nimule.

38. *MUS GRATUS* Thos.

♂. 56. Amala River.

39. *MUS TRITON* Thos.

♀. 8, 9. Mau, B.E.A.

40. *EPIMYS WALAMBÆ AMALÆ* Dollm.

Abstract P. Z. S. 1914, p. 25. (April 14.)

♂. 83, 84; ♀. 82. Narossura River.

♂. 38, 58, 72. Amala River.

♀. 29, 30. Lemek Valley.

♂. 91; ♀. 88. Lengototo.

Closely allied to *Epimys walambæ pedester* Thos.; distinguished by its smaller size, buff-tinted flanks, and much whiter ventral surface.

Dimensions of body and hind foot considerably less than in *pedester*.

General colour of dorsal surface quite like that of the Uganda form. Flanks washed with buff, the cold grey tint so conspicuous in *pedester* is here quite hidden by the buff coloration. Backs of hands and feet yellowish white. Ventral surface pale slate-grey covered with creamy white, the resulting effect being distinctly purer and whiter than in *pedester*, where the belly is quite grey. Tail rather lighter in colour, especially on the dorsal surface.

Skull smaller, with smaller molars and less inflated auditory bullæ.

Dimensions of the type (measured in the flesh):—

Head and body 144 mm.; tail 127; hind foot 26; ear 17.

Skull: greatest length 37·5 mm.; basilar length 31·3; condylo-incisive length 36; zygomatic breadth 20; interorbital constriction 5·5; length of nasals 15·5; palatilar length 18; length of palatal foramina 9·3; alveolar length of upper molar series 6·7.

Hab. Lemek Valley, between the Amala River and Southern Guaso Nyiro. Altitude 6500 feet.

Type. Old female. B.M. No. 13.10.18.111. Original number 30. Collected on October 8th, 1912.

This Rat is readily distinguished from the Uganda race by its smaller size, whiter belly, and buff-coloured flanks. Since *pedester* was described more fully adult specimens of this race have been received. The following dimensions are taken from an old individual collected by Mr. Robin Kemp at the type locality:—Head and body 196 mm.; tail 151; hind foot 33; ear 23·5. Skull (broken): palatilar length 20·2 mm.; length of nasals 17; zygomatic breadth 23·6; alveolar length of upper molar series 7·9.

41. *EPIMYS MEDICATUS* Wrought.

♂. 141. 45 miles N.W. of Baringo.

42. *EPIMYS JACKSONI* de Wint.

♂. 49. Amala River.

43. *EPIMYS NIVEIVENTRIS* Osg.

♂. 97. Narossura River, B.E.A.

A very dark specimen. The large series of this interesting Mouse collected by Mr. Percival show that it is subject to very considerable colour variation.

44. *EPIMYS COUCHA PANYA* Heller.

♂. 2. Mt. Suswa.

♂. 16, 17. Western Slope of Mau Escarpment.

♂. 35. Amala River.

Heller's type came from the Athi Plains. The specimens from Mt. Suswa and Mau are thus nearly topotypes, and appear to agree very closely with the description and with the topotypes in the Museum Collection.

45. *EPIMYS COUCHA PALLIDA* Dollm.

Abstract P.Z.S. 1914, p. 25. (April 14.)

♂. 199, 210, 211, 216, 220. Kamchuru, Lohor, Central Province, Uganda.

Allied to *Epimys c. neumani* Hell., smaller in size and without any buff-coloured suffusion on the ventral surface.

General proportions less than in *neumani* and *effectus* Dollm., hind foot only 20–22 mm. in length.

Colour of dorsal surface dark brown, between "olive-brown" and "hair-brown" (Ridgway, 1912), lined with black and washed over with pale buff, this latter tint most dominant on the flanks and

forming a yellowish line between the dark flanks and pale underparts. Backs of hands and feet white. Ventral surface of body slate-grey washed with white. Tail short, rather paler below than in *neumani*.

Skull small and slight in build, very like that of the other races of *coucha*.

Dimensions of the type (measured in the flesh):—

Head and body 87 mm.; tail 100; hind foot 21; ear 19.

Skull: greatest length 28 mm.; basilar length 22; condylo-incisive length 25·7; zygomatic breadth 13·2; interorbital constriction 4; breadth of brain-case 12; length of nasals 11·2; palatilar length 12·6; length of palatal foramina 7; alveolar length of upper molar series 5.

Type. Adult male. B.M. No. 13.10.18.99. Original number 220. Collected on February 14th, 1913.

While working on this group of multi-mammate mice I have come to agree with Heller in considering the forms *neumani*, *panya*, *effectus*, and other allies as races of *coucha*, and as such I have described this Kamchuru mouse.

46. THAMNOMYS SURDASTER, subsp.

♂. 87. Lengototo, B.E.A.

This specimen is so young that it is impossible to say to which of the many races of *surdaster* it belongs.

47. ZELOTOMYS HILDEGARDEÆ Thos.

♀. 76. West of Leganisho, B. E. A.

♂. 13. Mau, B.E.A.

♂. 5. Mt. Suswa, B.E.A.

The general external characters of this genus are well illustrated in these three specimens. The light coloured tail (due to the white skin more than to the colour of the short hairs covering same), the pale hands and feet, and thick, soft fur readily distinguish these mice from the members of the allied genus *Epimys*.

48. LOPHUROMYS ZENA Dollm.

♀. 6, 14. Mau, B.E.A.

49. ACOMYS IGNITUS Dollm.

♀. 96, 98. Narossura River.

♂. 108. Southern Guaso Nyiro.

50. ACOMYS ABLUTUS Dollm.

♂. 164. Near the Ngamatak Hills, Turkwel River.

51. ARVICANTHIS STRIATUS MASSAICUS Pagenst.

♀. 51; ♀. 47, 52, 53, 54. Amala River.

52. ARVICANTHIS ABYSSINICUS NAIROBÆ Allen.

♂. 94; ♀. 92. Lengototo, B.E.A.

These two specimens appear very similar in colour to the Nairobi *Arvicanthis*.

53. *ARVICANTHIS ABYSSINICUS RUBESCENS* Wrought.

♂. 221, 222. Patong, Uganda.

♂. 190, 191; ♀. 189. Bakoro, Uganda.

The type locality of *Arvicanthis a. rubescens* is Kibero, Unyoro; it appears to be distributed over a very large area, the British Museum possessing specimens from localities as far apart as Nimule and Ruwenzori.

54. *ARVICANTHIS ABYSSINICUS PRÆCEPS* Wrought.

♂. 130. Baringo.

This *Arvicanthis*, described from Naivasha, has already been recorded from Baringo, Mr. Kemp having obtained a large series of specimens both at Baringo and on the Laikipia Plateau.

55. *ARVICANTHIS TESTICULARIS JEBELE* Heller.

♂. 200, 213. Kamchuru, Lobar.

Central Province, Uganda.

56. *ARVICANTHIS RUMRUTI PALLESCENS* Dollm.

Abstract P. Z. S. 1914, p. 25. (April 14.)

♂. 20, 23, 24; ♀. 21, 22. Loita Plains.

♂. 115; ♀. 117. Southern Guaso Nyiro.

Allied to *Arvicanthis rumruti* Dollm.; larger in size and much paler in colour.

General proportions rather greater than in *rumruti*; hind foot 25–28 mm. in length.

Colour of dorsal surface pale olive-grey, lined with brownish black and washed over with a light yellowish tint. Flanks dirty white washed with pale yellow, gradually passing into the white ventral surface, without any marked junction of the two areas. Ears clothed with short yellow hairs, almost as brightly coloured and conspicuous as in the Somali species.

Backs of hands and feet yellowish. Ventral surface of body white; hairs longer than in *rumruti*, and the general effect very much whiter, owing to the dark basal portions of the hairs being hidden by the long white tips. Tail much as in *rumruti*, but rather paler throughout.

Skull larger than that of the Laikipia form, with larger molars and more inflated auditory bullæ.

Dimensions of the type (measured in the flesh):—

Head and body 133 mm.; tail 109; hind foot 26; ear 17.

Skull: greatest length 33 mm.; basilar length 27·7; condylo-incisive length 31·5; zygomatic breadth 17·8; interorbital constriction 5; length of nasals 12·7; palatilar length 15; length of palatal foramina 7·4; alveolar length of upper molar series 6·5.

Hab. Loita Plains, B.E.A. Altitude 6300 feet.

Type. Old male. B.M. No. 13.10.18.142. Original number 23. Collected on October 4th, 1912.

The affinities of this *Arvicanthis* are a little difficult to decide; it seems on the whole to be more nearly related to the *rumruti* species than its near neighbour *A. abyssinicus nairobiæ*. The Nairobi form is at once distinguished by its larger size and far richer and darker coloration.

57. *PELOMYS FALLAX IRIDESCENS* Heller.

♂. 57; ♀. 71. Amala River.

Heller, in his description of *iridescens*, points out that it is distinguished from *fallax* in possessing a heavier dorsal stripe. In the male specimen, now under consideration, the dorsal stripe is well marked; in the female, No. 71, the stripe is absent altogether. The type locality of *iridescens* is Mt. Mbolo, Taita Mountains, Seyidie Province.

58. *TACHYORYCTES NAIVASHÆ* Thos.

♂. 121, 123; ♀. 122. Naivasha.

♀ yg. 27. Lemek Valley.

59. *TACHYORYCTES RUDDI BADIUS* Thos.

♂. 10; ♀. 11. Mau, B.E.A.

60. *HYSTRIX AFRICÆ-AUSTRALIS* Pet.

♀. 64. Amala River.

61. *LEPUS VICTORIÆ* Thos.

♂. 1. Mt. Suswa, B.E.A.

♀. 41. Amala River.

♂. 197. Nakwai Hills, N. of Lake Kirkpatrick, Central Province, Uganda.

♂. 173. Kozibiri River, Uganda.

62. *OREOTRAGUS OREOTRAGUS SCHILLINGSI* Neum.

♀. 230. Narossura River, B.E.A.

♂. 187. Mt. Maroto, Uganda.

In *Oreotragus o. schillingsi* both sexes bear well-developed horns, a character which readily distinguishes this form from the closely allied *Oreotragus o. aureus* Heller; in the female specimen from the Narossura River the horns are quite as large as those of the male from Mt. Maroto.

63. *OUREBIA OUERBIA COTTONI* Thos. et Wrought.

♂. 193; ♀. 194. Bakora Plains, Lobar, Uganda.

♀. 65. Amala River, B.E.A.

♂. 77. West of Leganisho, B.E.A.

♀. 128. Baringo.

64. *RAPHICERUS NEUMANNI* Matsch.

♂. 93. Lengototo, B.E.A.

65. *RHYNCHOTRAGUS CAVENDISHI* Thos.

♂. 28. Lemek Valley, B.E.A.

66. *RHYNCHOTRAGUS NASOGUTTATUS* Lönnberg.

♂. 146. 12 miles N. of the Kerio River, B.E.A.

♀. 129. Baringo.

♂. 147. Wei Wei River, Rift Valley.

♀. 195. E. of Mt. Lobor, Uganda.

67. *CERVICAPRA CHANLERI* Rothschild.

♂. 95. Narossura River, B.E.A.

68. *GAZELLA GRANTI RAINEYI* Heller.

♂. 196. Bakora Plains, Lobor, Uganda.

♂. 136. 30 miles N.W. of Baringo.

69. *CEPHALOPHUS GRIMMIA LUTEA* Dollm.

Abstract P. Z. S. 1914, p. 26. (April 14.)

♂. 178; ♀. 180. Mt. Maroto, Maroto Stream, Uganda.

♂. 226. Falabek, east of Nimule.

Allied to *Cephalophus g. abyssinicus* Thos., distinguished by its far paler colour and larger teeth*.

Colour of dorsal surface pale greyish buff, the buff tint most dominant on the neck, shoulders, and flanks, becoming greyer on the hind quarters and back; neck and shoulders "light pinkish cinnamon" (Ridgway, 1912) mixed with the dark brown tint of the hair-bases; hind quarters "smoke-grey" speckled with dark brown. Face and head markings as in the other members of the group. Ventral surface of the body much as in the allied forms.

Dimensions of the type (measured in the flesh):—

Head and body 870 mm.; tail 76; hind foot 225; ear 101.

Skull: greatest length 169 mm.; basal length 150; zygomatic breadth 77·5; greatest width across orbital region 79·8; length of nasals 57·8; greatest breadth across nasals 31; palatal length 84; length of upper cheek-teeth 51·5.

Hab. Mt. Maroto, Maroto Stream, N.E. Karamoja, Central Province, Uganda. Altitude 3703 feet.

Type. Old female. B.M. No. 13.10.18.164. Original number 180. Collected on January 25th, 1913.

The type is the only fully adult specimen collected; of the others No. 178, a subadult male, possesses horns like those of *abyssinicus*. This Uganda race is easily distinguished from the allied forms by the pale greyish-buff colour of the dorsal surface; the Duikers most nearly allied are the Abyssinian *C. g. abyssinicus* and *C. g. nyansæ* Neum., from the Guaso Ngishu District. In general colour this Uganda Duiker is surprisingly like the South African *grimmia*, the buff on the shoulders and flanks being rather more dominant in this new race. *Cephalophus g. hindei*, described by Wroughton from specimens collected at Fort Hall, appears as a bright orange-buff coloured animal when compared with this Uganda Duiker.

* In the Abstract of this paper the teeth were erroneously stated to be "smaller" than those of *C. g. abyssinicus*.

22. On the Nature of the Lateral Muscle in Teleostei. By
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[Received February 2, 1914: Read April 7, 1914.]

(Text-figures 1-3.)

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1. INTRODUCTORY.

During the past two years my research hours have been largely devoted to a study of the myology of the pectoral girdle and fin of fishes, and recently the Teleosteans have more particularly occupied my attention. As the musculature of the limbs is entirely derived from the so-called lateral muscle, it is desirable, in the first instance, accurately to comprehend the nature of the lateral muscle.

That the primitive composition of the lateral muscle, seen only in the embryonic condition of living fishes, becomes highly modified in the adult Teleostean is beyond doubt; but it is difficult to reconcile the views of various authors, some of whom interpret it in terms of two superimposed layers and others in terms of one layer. It would be obviously unwise to advance to a description of the myology of the limbs while this fundamental question is left undecided. To uphold the single-layer theory of the lateral muscle in Teleostei is, then, the primary object of the present paper.

The complex series of cranial muscles is also derived from the lateral muscle, but the secondary modifications which they have undergone render highly problematical any conclusions based on their arrangement. For this reason the cranial muscles will only receive passing consideration. The brunt of the discussion will be focussed upon that portion of the lateral muscle which lies behind the pectoral girdle; and, in particular, upon the caudal region, which is generally accepted as the least modified.

Though not a primary part of my research, the conclusions advanced below are the outcome of it; and they are offered as a preface to a section of an original morphological study.

I wish to record my gratitude to the Carnegie Trust, whose

* Communicated by Prof. W. C. McINTOSH, F.R.S., C.M.Z.S.

grant in aid of research provided me with an image-erecting binocular microscope, invaluable in tracing the intricate courses of muscle-fibres, giving comprehensive stereoscopic views of the muscle such as are unobtainable by simpler forms of optical apparatus.

HISTORICAL.

Owen (8) emphasizes the fact that the lateral muscle is essentially an aggregate structure formed of a series of transverse muscles (myomeres). The divisions of the lateral muscle which he cites are based on the directions of the myocommata ("tendinous insertions"); but he does not regard these as having any true morphological value. The carinales, however, are regarded as entities. I can find nothing in Owen's writing to show that he regarded the lateral muscle as divisible into two layers.

Humphry (4) recognises a true division of the lateral muscle, by a septum passing inwards beneath the lateral line, into a dorsal and a ventral moiety. His subsequent divisions of these moieties are based on the directions of the myocommata; at the same time he states that when these divisions are traced forwards to their insertions they become completely severed one from the other. The red fibres occur superficially on either side of the lateral line. The latero-ventral portion of the muscle (see table) is divided by the direction of its component fibres into a superficial layer (*obliquus externus*) and a deep layer (*ob. internus*), but there is no septum between these two layers. In this portion a third layer was noted in certain Teleosts (Bream, Dace), which, from its position beneath the ribs, was regarded as a possible homologue of the transversalis layer of Amphibia. Similar changes in the direction of the fibres enabled Humphry to distinguish three areas of the mesio-ventral portion, two superficial and one deep, but these again were not defined by fasciæ.

Gegenbaur (3) also recognises a horizontal plane of division at the lateral line whereby a dorsal is separated from a ventral moiety. He proceeds to divide these moieties in terms of cones, complete and incomplete, which are revealed in sections of fishes. It is desirable here to draw attention to a discrepancy which is displayed in the illustration fig. 276, A, which represents the time-honoured caudal section of a Mackerel, originally drawn by J. Müller, of which Owen (amongst others) has made use. Gegenbaur's description of this section is perfectly lucid, and more precise than Owen's; but, unfortunately, he has added a diagram of the superficial arrangement of the myocommata (fig. 276, B), wherein, if we may judge by the lettering, he represents the upper cones (*a*) as identical with the cones seen in section in fig. 276, A*a*. In reality the superficial cones are directed posteriorly and their apices represent the angles which the uppermost superficial fibres of the true cones make with fibres of the incomplete cones (which are directed downwards and backwards), whereas the true cones are directed anteriorly

and, being deeply seated, are not visible superficially. Moreover, the apices of the superficial cones are of necessity situated in a higher horizontal plane than those of the true cones.

The five longitudinal portions of the lateral muscle which McMurrich (7) derived from his investigation of *Amiurus* are equivalent to various areas described by previous authors. This is indicated by the positions which they take in the above table. The author implies that the classification is only of empirical value. His divisions are based upon the superficial appearance of the muscles, and upon the extent of their origins. He does not recognise a clear division beneath the lateral line, nor is there any suggestion of stratification in any portion of the lateral muscle.

Maurer (6) divides the lateral muscle into two portions, a dorsal and a ventral, separated by the lateral line. The dorsal portion is outside the sphere of his investigation, the ventral he proceeds to split into layers.

If the red fibres * immediately ventral to the lateral line be removed, a stout muscular layer is observed whose fibres run obliquely, from forwards and upwards to backwards and downwards (*i. e.* in the same direction as those of the obliquus externus of Amphibia). The outermost layer of this muscle runs from septum to septum, the inner from rib to rib; since, however, the direction of the fibres does not change, the two layers are regarded as comprising a single muscle, the obliquus externus †.

Ventrally the origins of the fibres of this muscle change so as to resemble those of the obliquus internus of Urodeles ‡, while the fibres which meet in the mid-ventral line their fellows of the opposite side go to form a rectus.

Returning to the area of the ventral muscle immediately below the lateral line, where the fibres take the direction of the obliquus externus of Amphibia, if the superficial fibres be removed a deep layer is found whose fibres slant in the opposite direction (*i. e.* from forwards and downwards to backwards and upwards, like those of the obliquus internus of Amphibia). These fibres form a thin deep stratum running from rib to rib §. There is no mention, however, of a fascia separating the deep from the superficial stratum.

Beneath the above layers is yet a third, in *Chondrostoma*, at least; this is spoken of as a thick one covering the peritoneum ||.

The rectus is not, he says, developed as a costal muscle, rather as a ventral part of the primary belly-musculature ¶.

* The occurrence of these red fibres is more fully described on p. 326.

† The equivalent of Humphry's latero-ventral (surface) portion.

‡ This and the superficial layer of the next form the "pectoralis" of Humphry.

§ Equivalent in all respects to Humphry's "obliquus internus."

|| This is apparently equivalent to the transversus stratum which Humphry observed in the Bream and Dace. Nevertheless, Maurer states that the transversus properly so called is absent in all fishes.

¶ From which I gather that this muscle is regarded as being continuous dorsally both with the obliquus externus and with the obliquus internus. It thus included the "rectus" and ventral portion of "pectoralis" of Humphry.

Here we have an exposition of the two-layer theory of the lateral muscle of Teleostei, differing in few points from that advanced by Humphry.

Wiedersheim (9) describes the completeness of the division of the dorsal and lateral moieties of the lateral muscle by a connective tissue septum extending from the axial skeleton to the integument at the region of the lateral line. Only one layer of muscle is recognised.

With Knauer (5) we are brought into contact with a new view of the lateral muscle. It is divided longitudinally into two main portions which are defined according as they arise from (a) the head (Rückenmuskulatur) or (b) the neck (Bauchmuskulatur). The division at the lateral line, though complete, is only regarded as being of secondary importance. The oblique line in the table severing the back musculature from the belly musculature indicates the author's contention that the former gradually pushes its way over the latter as we proceed in an antero-posterior direction. Finally, in the posterior abdominal region the back musculature comes completely to enclose the diminishing belly musculature; and in this area a true stratification of the body-wall is realized. His lateral line muscle is synonymous beyond doubt with the "red fibres" of other authors.

Text-figure 1.

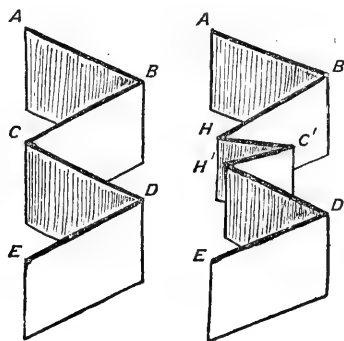


Diagram to illustrate the apparent (ABCDE) and the real (ABHC'H'DE) construction of a myomere. (After R. Chevreton.)

Dietz (2) bases his division of a Teleostean myomere, and hence of the lateral muscle, on the transverse septum extending beneath the lateral line. His subsequent divisions are due to the direction of the myocommata. He proceeds to investigate myomeres from various parts of the body, and shows how the pleuro-dorsal portion gradually becomes emancipated from the pleuro-ventral as we proceed antero-posteriorly; with this is correlated the

change of a single half myomere, dorsal or ventral, from a single bend to a double bend*.

Chevrel (1) has given a lucid description of the conical, or pyramidal, structure of the myomeres forming the lateral muscle. His diagram illustrative of the apparent and the real structure of a single typical Teleostean myomere is reproduced here (text-fig. 1). At B is seen the dorsal posterior pyramid, at H the anterior dorsal pyramid, at H' and D the ventral pyramids, while C indicates the lateral line. It is only necessary to add that in the abdominal region the dorsal moiety (portion épiaxiale) alone exhibits this double evagination; the ventral (portion hypoaxiale) is ribbon-like. Chevrel recognises a horizontal septum dividing completely a dorsal from a ventral moiety; but there is no mention of stratification in any area of the lateral muscle. The carinales (m. grêles) are the homologues behind the pelvis of the rectus which is found in the thoracic region.

THE AUTHOR'S OBSERVATIONS.

Having now stated the principal views extant as to the divisions of the lateral muscle in Teleostei, the conflicting nature of these becomes patent. I shall next proceed to formulate a classification of the parts of the lateral muscle, retaining such features as are agreed upon by the majority of the investigators whose work I have studied, and discarding those which I find to be incapable of general application. In this classification no new terms will be introduced, preference being accorded to those which are deemed most descriptive. I wish it clearly to be understood that I regard any such classification, in the light of our present limited knowledge, as essentially empirical and tentative.

That the so-called lateral muscle of fishes is, more strictly speaking, a sequence of serially homologous transverse muscles (myomeres) is the fundamental starting point upon which all investigators are agreed. Setting this fact in the background, but never letting it completely out of sight, let us proceed first to map out the superficial divisions of this muscle in a Teleostean, and then to prove by dissection the morphological value of these divisions.

No specified type has been taken; but the description, and herein lies what merit it possesses, is so generalised as to apply to the majority of Teleostean fishes. Exceptional cases will be cited wherever practicable.

(1) *External Conformation.*

The most obvious longitudinal division giving rise to a dorsal and a ventral moiety is formed by the passage of the lateral line. Upon this point there is but one voice.

* This process can be very clearly followed in Knauer's drawings of Salmon sections, *op. cit.* pl. iii. figs. 15-19.

Tabulated Summary of the

	OWEN (8).	HUMPHRY (4).		GEGEN- BAUR (3).	McMURRICH (7).	MAURER (6).	
		<i>Superficial.</i>	<i>Deep.</i>			<i>Superficial.</i>	<i>Deep.</i>
DORSAL MOIETY.	<i>Supra-</i> <i>carinalis.</i> Dorsal Section.	Mesio-dorsal Portion.		Incomplete Cones (directed backwards).	1st Portion.		
	Dorsal Middle Section.	Latero-dorsal Portion.		Entire Cones (directed forwards).	2nd Portion.	Dorsal Portion.	
Lateral line. }		<i>Red fibres.</i>				<i>Red fibres.</i>	
		<i>Red fibres.</i>				<i>Red fibres.</i>	
VENTRAL MOIETY.	Ventral Middle Section.	Latero-ventral Portion. Obliquus externus.	Obliquus internus.	Entire Cones (directed forwards).	3rd Portion.	Obliquus externus.	Obliquus internus.
	Ventral Section.	Mesio-ventral Portion { Lat. dorsi Pectoralis.	Rectus.	Incomplete Cones (directed backwards).	4th Portion.	{ Diagonal fibres (sloped as in Obl. internus).	
	<i>Infra-</i> <i>carinalis.</i>	<i>Carinales.</i>			5th Portion.	Rectus.	

With regard to the dorsal moiety, of the writers quoted above, McMurrich, Maurer, Wiedersheim, and Knauer see no reason for a further subdivision. The remainder, however, favour a division, but are divided as to the nature of that division, Owen and Humphry using the external appearance as a basis, while Gegenbaur, Dietz, and Chevrel refer to it in terms of internal cones (the difference will subsequently be shown to be of less degree than at first sight appears). The myocommata of the dorsal moiety in the trunk region are V-shaped, the apex of the V being directed posteriorly. The inclination of the V varies from an acute to an obtuse angle. Between two successive myocommata the muscle-fibres have often been said to run parallel to the long axis of the body. This is the case in the middle region, but, in the arms of the V, the fibres gradually become more or less inclined in the same direction as the arms; that is to say, if produced, the fibres in the upper and lower arms would meet behind the V. With Humphry, we will denote that portion of the dorsal moiety which contains the upper backwardly directed arms of the V as the mesio-dorsal portion, and that which

Views of the Authors cited.

WIEDERSHEIM (9).	KNAUER (5).		DIETZ (2).	CHEVREL (1).
{ Dorsal Portion. }	<i>Superficial.</i>	<i>Deep.</i>		
	Straight Back-muscle.		Dorsal proper.	{ Dorsal Portion. Posterior, external, or superficial Pyramids. Anterior, internal, or deep Pyramids. }
	Back (Rücken) Musculature.		Pleuro-Dorsal.	
	<i>Lat. line muscle.</i>			<i>Red fibres.</i>
{ Ventral Portion. { Analogue of Obliquus. Analogue of Rectus. }	<i>Lat. line muscle.</i>			<i>Red fibres.</i>
	Oblique Back-muscle.		Pleuro-Ventral.	{ Ventral Portion. Anterior, internal, or deep Pyramids. Posterior, external, or superficial Pyramids. }
	Belly (Bauch) Musculature.	Oblique Belly-muscles.	Ventral Proper.	
	(Rectus). Straight Belly-musclés.			
	Muscles grêles.			

contains the lower backwardly directed arms as the latero-dorsal portion (see text-fig. 2, *M.D.*, *L.D.* p. 331). In the trunk region there is no distinction between the mesio-dorsal and the latero-dorsal portions except in the direction of their fibres, and, even then, the differently directed fibres are connected by a transitional area. Tracing these portions forwards to the back of the head the two are found gradually to be severed from one another; strong fasciæ separate them; their transverse divisions begin successively to fade and disappear; and, finally, they are inserted on the skull, the mesio-dorsal portion on its roof (supraoccipital), the latero-dorsal portion on its side (exoccipital and otic recess) and on the post-temporal; the last named gives off a superficial branch to the supraclavicle (*Blennius pholis*) or to the cleithrum itself (*Cottus scorpius*, where it is attached to the posterior border of the backwardly directed spine in which that bone ends).

In the little gobiiform fish, *Periophthalmus*, the mesio-dorsal portion is attached to the upper border of the post-temporal as well as to the supraoccipital; but this so far as my observations go is an exceptional occurrence.

In the majority of Teleosteans a small muscle is cut off from the latero-dorsal portion immediately above the lateral line. From the distinctive coloration which it frequently presents it has become known as the "red muscle" or "red fibres." It is not merely differentiated from the latero-dorsal portion by the colour of its fibres, or even by their direction, which is parallel to the long axis of the body (whereas those of the main muscle are directed slightly upwards and backwards); but a distinct fascia separates it in each myomere (see text-fig. 3, *r.f.* p. 334). A similar "red muscle" is cut off from the latero-ventral portion immediately below the lateral line. The "red muscle" is mentioned by Chevrel; we have seen that it was also recognised by Maurer. Chevrel states in another part of his text that this muscle is constant neither in presence, nor in form, nor in tint, nor even in its relations with the lateral nerve. Further, in Humphry's paper (*op. cit.* p. 294) the following words in reference to fishes appear in a footnote:—"..... and the lateral furrows are commonly occupied by muscular fibres which bear the transverse septa, but which are more closely connected with the skin, and peel off with it more easily than the rest of the lateral muscle. These fibres are more vascular than ordinary muscular fibres; and in a piece which I examined from a Dace they contained more oil than the other muscles. Stannius (*Handbuch der Zootomie* (2), 112) says that they, in addition, present microscopically the appearance of tissue in process of conversion into muscle. I did not find that to be the case. With the exception of the excess of oil, they represented the usual microscopical characters of striped muscle." Such observations as I have made go to support Humphry's statements. The "red muscle" gradually disappears anteriorly, so that it never reaches the shoulder-girdle.

Turning next to the ventral moiety, we find, in the trunk region, an exact repetition of the condition that has been described for the dorsal moiety. Following Humphry's nomenclature, which we have used above, let us designate the area immediately below the lateral line, comprising the backwardly and downwardly directed arms of the V-shaped myocommata, as the latero-ventral portion, and the area between this and the mid-ventral line (or the infracarinales muscles, where such are present) as the mesio-ventral portion (see text-fig. 2, *L.V.* and *M.V.*). It will be apparent, on turning back to the tabulated summary of the views of the various authors, that this division of the ventral moiety of the lateral muscle meets with more general recognition than does a corresponding division of the dorsal moiety. Tracing these portions forward to the shoulder-girdle, we find that the apices of the backwardly and downwardly directed V-shaped myocommata rapidly approach the lateral line: in other words, the latero-ventral portion rapidly disappears. McMurrich states that this portion (his "3rd portion") disappears in *Amiurus* before reaching the shoulder-girdle; such is

the case in some other Teleosteans, but in the majority which I have examined a small bundle of fibres, undoubtedly the continuations of the latero-ventral portion, are attached to the upper extremity of the cleithrum. At its point of attachment and for a short distance behind, the latero-ventral portion is actually severed from the mesio-ventral; though, further back, the two are continuous, just as are the mesio-dorsal and latero-dorsal portions. With the decrease in width of the latero-ventral portion, the mesio-ventral portion increases so that it becomes attached to the whole length of the cleithrum, except at the dorsal extremity of that bone, and to the coracoid in part. There exists, however, a triangular area, composed of connective-tissue traversed by a few muscle fibres, beneath the pectoral fin; this triangle has its base on the cleithrum, consequently there appear to be two main insertions of the mesio-ventral portion on the cleithrum.

On the ventral surface in the anterior region the fibres of the mesio-ventral surface meet their fellows of the opposite side; the fibres are here arranged parallel to the long axis of the body, which has led some authors to regard them as homologous (Humphry and Maurer), or, at least, analogous (Wiedersheim) to the rectus abdominis of the higher vertebrates. In Teleosteans whose pelvic fins are thoracic or jugular in position the ramifications of this portion of the lateral muscle show remarkable variety. To describe these ramifications in detail would only serve to confuse the issue of the investigation in hand; but it is worthy of note that, in every example which I have had occasion to examine, a bundle of fibres from the mesio-ventral portion of the lateral muscle runs forward without interruption to be inserted on the hypohyal.

Knauer (5) figures the lateral muscle of the Gurnard in the area just behind the shoulder-girdle (Pl. iii. fig. 20). In this illustration the mesio-ventral portion (Bauchmuskel) is depicted as gradually disappearing towards its posterior extremity, and in the text he says that in the anal region this muscle, with its straight-running fibres, is reduced to a small strip on either side; further, that these strips fuse with the latero-ventral portions (Rückenmuskulatur) behind the anus. This is not indicated in the figure, where the mesio-ventral portion appears to die out in the anal region; *Trigla*, however, with its flattened ventral surface is not, perhaps (with deference to the author), the best type of Teleostean fish for representing in side view the entire extent of this portion of the lateral muscle. A little distance behind the anus the mesio-ventral portion entirely disappears, and the latero-ventral portions (schrägen Rückenmuskel) of either side are separated by the anal fin. I had also used Gurnards* in my investigation of the lateral muscle. Since reading Knauer's paper, I have examined them again most

* *Trigla gurnardus*, whereas Knauer's specimen was *T. hirundo*.

carefully, and with the result that I still maintain that the mesio-ventral portion is continued to the extremity of the tail in that species just as has been described above for Teleosteans in general.

There remain yet to be considered the small cylindrical muscles known as carinales. These may be absent, and, when present, exhibit considerable variety in their extent. The upper pair, supracarinales, run parallel to one another along the mid-dorsal line, separating the mesio-dorsal portions of either side of the main lateral muscle-masses. They take origin on the occiput in the Cod (Owen), whence they run to the first dorsal, and reappear again in the interspaces between the dorsal fins; in *Periophthalmus* they arise slightly behind the skull from the neural spines, and traverse the interspaces between the dorsal fins; in *Amiurus* they only appear behind the first dorsal fin, and McMurrich describes them as "formed by the union of slips arising by tendons from the spinous processes." They are separated by strong fasciae from the main masses of the lateral muscles, but retain their original metameric segmentation. Functionally they act, according to their position, as elevators or depressors of the dorsal fin-rays. They may be regarded as specialised modifications of the lateral muscle, just as are the other fin-muscles.

The lower pair, infracarinales, are similar in nature to the foregoing muscles, and, when present, divide the mesio-ventral portions of either side of the lateral muscle. Both Owen and McMurrich, who have described them, agree that they may be divided into an anterior and a posterior section. The latter extends from the posterior end of the anal fin to the base of the caudal, and between the two anal fins where such occur. The former extends from the anterior end of the anal fin to be inserted on the posterior face of the pelvic bone (ischium, Owen); hence they describe it as the "retractor ischii," and Owen goes so far as to describe in the Perch the "protractor ischii" as a still further anterior prolongation of the same muscle.

A difficulty now arises. In many Teleosteans, especially in forms whose pelvic girdles are situated far forward, the "retractor ischii" a short distance behind its origin on the posterior aspect of the pelvic bone becomes inseparably fused with the mesio-ventral portion of the lateral muscle; or, in other words, part of the mesio-ventral portion forms in many cases the "retractor ischii." It would seem that the latter condition is more primitive than that where the "retractor ischii" is composed of a carinalis muscle, which has been noted as a secondary modification of the lateral muscle. Yet the "retractor ischii" composed of an infracarinalis occurs for the most part in Teleosteans with abdominal pelvic fins, that is to say, in the more primitive forms; and *vice versa*, the (presumably) more primitive condition of the "retractor ischii" occurs in the more specialised Teleosteans. This interesting anomaly is beyond the scope of the present investigation; it recalls frequent analogous occurrences in the

evolution of animals, and is merely noted here as a bye-way which might repay exploration.

Summary of the external divisions of the lateral muscle:—

1. Supracarinalis.
2. Dorsal moiety.
 - (a) Mesio-dorsal portion.
 - (b) Latero-dorsal portion.
3. "Red Muscle."

(Lateral Line.)
4. "Red Muscle."
5. Ventral moiety.
 - (a) Latero-ventral portion.
 - (b) Mesio-ventral portion.
6. Infracarinalis.

(2) *Internal Structure.*

In the foregoing section we have named the outstanding superficial divisions of the lateral muscle in Teleosteans. Let us now proceed to prove by dissection to what extent these external markings are evidence of internal structure. Enough has already been said of the carinales and of the "red muscles" to show that these are specialised offshoots from the lateral muscle; and, since all the authors who have mentioned them are agreed as to their morphological value, it would be superfluous to treat of them at greater length in the present paper; suffice it to say that there is no question of their division into more than one stratum, nor are they themselves regarded in the light of strata, deep or superficial, of the lateral muscle. Let us concentrate our attention upon the dorsal and ventral moieties of the main mass of the lateral muscle.

With the exception of Owen and McMurrich, all the authors whom I have quoted maintain the completeness of the division at the lateral line. Dissection shows a well-marked septum running continuously from beneath the lateral nerve to the bodies of the vertebræ. The lateral line, then, must be regarded as the external evidence of a true horizontal division of the lateral muscle.

Having established this fundamental division, let us enquire to what extent the dorsal moiety may legitimately be subdivided. It has been shown that it comprises superficially, (a) a mesio-dorsal portion, in which the fibres of each myomere are directed from above anteriorly to below posteriorly, and (b) a latero-dorsal portion in which the fibres take the opposite direction. On stripping the superficial fibres from the latero-dorsal portion of a typical myomere such as occurs in the caudal region, it is found that the direction of the underlying fibres gradually changes so as to become, first, parallel with the long axis of the body, and then, very near to the vertebral column, from above anteriorly

to below posteriorly (like those of the superficial area of the mesio-dorsal portion).

It is this change in direction of the fibres which led Humphry and Maurer to distinguish two layers in the ventral moiety of the lateral muscle. If Chevrel's account of the internal structure of a myomere has been followed, the reason for this change in direction of the fibres will be perfectly clear. Since the ventral half of the dorsal moiety of the myomere takes the form of a pyramid with its apex directed anteriorly, of the fibres running from the apex the uppermost ones may be expected to take a direction from below anteriorly to above posteriorly, and the lower ones from above anteriorly to below posteriorly; and this is indeed the case. Moreover, since the apex is directed inwards and downwards, only the outer upper faces of the pyramids on which the fibres are directed from below anteriorly to above posteriorly, is visible externally, and has been designated the "latero-dorsal portion" in our superficial examination. The lower face, on the other hand, in which the fibres are directed from above anteriorly to below posteriorly, is hidden beneath the surface.

Similarly, the portion which has been designated "mesio-dorsal" in our superficial examination represents the outer face of a backwardly directed pyramid.

It has already been mentioned that, just behind the head, near the insertions of the mesio-dorsal and latero-dorsal portions of the lateral muscle, these two masses are divided. The division is not merely superficial, but extends usually throughout their depth; though in some forms (*Cottus scorpius*) a certain number of strands from their deeper contiguous faces serve to connect them almost up to the point of their insertions.

The above description of the arrangement of the dorsal moiety of a myomere of the caudal region applies equally well to the ventral moiety in the same region, only the direction of the apices of the pyramids is reversed, the dorsal one being directed anteriorly, the ventral posteriorly. Here, again, only the outer face, but in this case the lower, of the anteriorly directed pyramid, with its fibres running from above anteriorly to below posteriorly, is visible externally, where it is recognised as the "latero-ventral portion" of our superficial examination; while beneath it lies the upper face, in which the fibres run in the opposite direction, namely, from below anteriorly to above posteriorly. Hence the explanation of the description in this portion of the lateral muscle of two superimposed strata, equivalent respectively to the obliquus externus and obliquus internus of higher vertebrates, advanced by Humphry and Maurer.

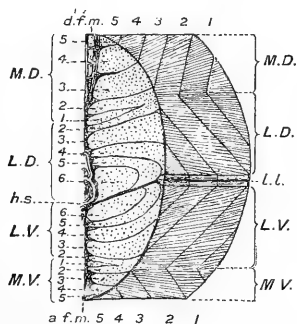
In the abdominal region, where the walls of the ventral moiety are of necessity thin, the conical structure of the myomere is lost. The latero-ventral portion throughout its depth contains fibres which are directed from above anteriorly to below posteriorly, at least in its most anterior area. It acquires its

characteristic conical structure, however, considerably further forward than does the mesio-ventral portion. The latter contains fibres which are directed from below anteriorly to above posteriorly on the lower parts of the flanks; but, as noticed above, the fibres of the ventral surface change in direction the nearer they approach to the mid-ventral line so as to be disposed parallel to the long axis of the body. I have failed in every instance to find a septum, such as is described by Knauer, dividing the mesio-ventral portion into two superimposed layers.

It has been stated above that a strand of the mesio-ventral portion is prolonged anteriorly to be inserted on the hypo-hyal. This strand, together with the hyo-cleithrale*, constitutes the neck musculature. Knauer (5) recognised these parts of the neck musculature, and adds the following note (*op. cit.* p. 11):—

“Die Angabe Schneiders, dass sich der *Sternohyoideus** aus zwei der Länge nach zusammengewachsenen Muskeln (Hyo-dorsalis und Hyoventralis) zusammensetzt, die als Fortsetzung des Rückenmuskels und des Rectus zu betrachten sind, ist dadurch zu verstehen, dass Schneider offenbar schon die oben erwähnte Fortsetzung der inneren Schichte (von ihm als Rückenmuskulatur aufgefasst) in die Halsmuskulatur bemerkte.”

Text-figure 2.



Transverse section through the caudal region of a typical Teleostean with the contiguous body-surface, to show the relations to one another of six consecutive myomeres. The right side of the figure represents the anterior portion of the section. (Generalised, mainly from *Cottus scorpius*.)

M.D., Mesio-dorsal portion; *M.V.*, Mesio-ventral portion; *L.D.*, Latero-dorsal portion; *L.V.*, Latero-ventral portion; 1-6, consecutive myomeres, the first is anterior; *h.s.*, horizontal septum; *l.l.*, lateral line (with “red fibres” on either side of it); *a.f.m.*, anal fin-muscle; *d.f.m.*, dorsal fin-muscle.

I, too, have noted this double condition of the hyo-cleithrale in certain Teleosteans (*Lophius*, *Trigla*, *Zeus*). My observations

* A revised term more accurately descriptive of the muscle hitherto known as hyo-clavicularis (synon. *Stenohyoideus*, *Cervicalis profundus*, etc.).

tend to indicate that the division line is horizontal rather than tangential; that is to say, they support Schneider's view.

Chevreul's diagram of the pyramidal disposition of a caudal myomere has been reproduced on p. 322 (text-fig. 1); the accompanying illustration (text-fig. 2) will serve to convey a more realistic view of the manner in which the pyramids fit one into the other. Let us follow in turn the course of six myomeres represented in the text-figure.

First myomere.—This is seen at the surface on the right of the text-figure (1). In the mesio-dorsal portion (*M.D.*) its fibres are directed from above anteriorly to below posteriorly, in the latero-dorsal portion (*L.D.*) the fibres are directed from below anteriorly to above posteriorly; in the ventral moiety (*L.V.* and *M.V.*) this sequence is repeated. The dorsal moiety is separated from the ventral by the lateral line (*l.l.*) and by the "red fibres" on either side of it. Looking into the section, we find the first myomere (1) in the form of an acute angled triangle with its base abutting on the vertical septum, in which run dorsally the neural spines and ventrally the hæmal spines; it presents a similar appearance both in the dorsal and ventral moieties.

Second myomere.—Seen at the surface immediately behind the foregoing, it takes a similar course; the posteriorly directed apices of its V-shaped bends are broken, however, by the section. Following its course into the section we find that it presents a V-shaped mass which bestrides the triangular section of the first myomere.

Third, fourth, and fifth myomeres.—These are seen externally, each at four points, as a series of gradually vanishing segments of the V-shaped arms (the fifth myomere, however, does not appear superficially in the central region). In section each presents four quadrangular faces, two above and two below the horizontal septum. Near the middle line the faces become curved, so that they present a convex surface to the exterior and a concave surface to the interior.

Sixth myomere.—This does not appear superficially, but is seen as a roughly triangular mass on either side of the horizontal septum. The base of the dorsal triangular mass rests against the body of the vertebra, that of the ventral one against the hæmal arch. The outer angles of these triangles, unlike those of the sections of the first myomere, are rounded off, and fit into the concave inner surfaces of the fifth myomere.

Having obtained a sequence of views of a series of consecutive myomeres, let us proceed to reconstruct from them the conformation of a single myomere. As the ventral moiety of a myomere is the counterpart of the dorsal, it will be sufficient to confine our remarks to the latter.

It is evident from the foregoing observations that a myomere is not visible superficially in its most anterior region. We have seen it (6) as a triangular area in the angle between the centrum and the horizontal septum. By dissection it is easy to demonstrate

that this triangle represents the base of a pyramid which converges to an apex on the centrum*. Tracing the sixth myomere backwards through the width of a myomere, we should find it to show the appearance of No. 5 in the text-figure; it has then been thrust from contact with the vertebral column by the appearance of a new pyramid: moreover, it has made its anterior superficial appearance dorsally. Backwards again through the width of another myomere it has the appearance of No. 4; here a considerable portion of it is visible externally, both dorsally and just above the "red fibres"; in this and in its next stage, No. 3, it appears in section as two quadrangular faces which are approaching one another. In No. 2 we are able to see how the two faces, whose superficial continuations are now recognisable as the mesio-dorsal (*M.D.*) and latero-dorsal (*L.D.*) portions respectively, become confluent. Passing from this point through the width of another myomere the two faces are found fused into one triangular area (1, in section), which is invisible externally owing to the convergence of the faces of the myomere next in front. By dissection it can be demonstrated that this triangle forms the base of a pyramid whose apex is attached to the vertical septum.

Thus it is seen that the dorsal moiety of a myomere is composed of two opposed hollow pyramids, a dorsal one directed inwards and backwards, and a ventral one directed inwards and forwards. They are not divided by a septum but share a common face, which may be seen in the text-figure at the areas marked 2, 3, 4, and, in part, 5 in the *L.D.* portion of the section†.

The ventral moiety of the myomere takes a course symmetrical with the dorsal, which it resembles in all essential points of structure.

Before leaving this figure it would be well to observe that it serves admirably to indicate why there is but one change in direction of the external fibres, correlated with the change which the conical structure involves, in each moiety of the myomere, instead of the two which one would be led to expect. Following the central course of myomere No. 4, it is seen that only the fibres above the mesial plane of the *L.D.* portion, and below that of the *L.V.* portion, are visible at the surface. The fibres below the mesial plane of the *L.D.* portion and above that of the *L.V.* portion, which take the opposite directions respectively to those named in the preceding sentence, are only found in myomeres 5 and 6; and these do not appear on the surface.

I have also followed the course of the myomeres in the dorsal moiety of a young Salmon through over a hundred consecutive sections from the pelvic region. Two such sections are reproduced here (text-fig. 3) to indicate the directions of growth and diminution in seven consecutive myomeres. As corroborative

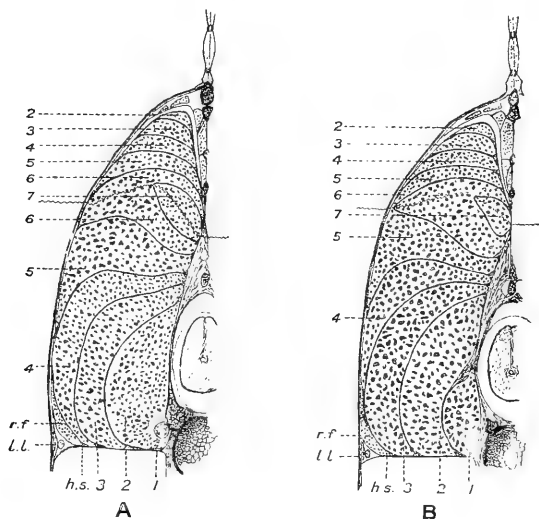
* This will be corroborated in the remarks on sections of a young Salmon, p. 334.

† It is evident that this area may be regarded as the forward continuation of a pyramid similar to 1, or as the backward continuation of a pyramid similar to 6.

evidence of the above observations the figures speak for themselves; but the essential features which I wish to emphasize are these:—

First, that the horizontal septum (*h.s.*) running from the lateral line to the vertebral centra is continuous; also that the “red fibres” (*r.f.*) remain constant in position and extent, thereby showing that they form no part of the system of pyramids or cones.

Text-figure 3.



Two transverse sections through the dorsal moiety of the lateral muscle of a young Salmon (34.5 mm.) taken from the pelvic region.

A represents a plane .064 mm. anterior to B; 1-7, series of myomeres, identical in both sections; *h.s.*, horizontal septum; *l.l.*, lateral line; *r.f.*, “red fibres” ~~~, arbitrary internal division-plane between the mesio-dorsal and latero-dorsal portions.

Secondly, that the numbers are not merely written down symmetrically on either side of an arbitrary starting point. Where any two parts of myomeres are numbered as the same myomere, this has actually been proved to be the case by tracing their passage through a sufficient number of sections until they become confluent one with the other; to take an example, the separate parts denoted by the number 5 in A, become confluent when traced backwards to their position in B 5.

Thirdly, that the ventral, forwardly directed pyramid is seen at its origin at A 1, and again, considerably increased in bulk, when traced backwards to its position at B 1; conversely, that the dorsal posteriorly-directed pyramid is seen decreasing from A 7 to B 7.

Fourthly, that at the outermost extremity of myomere B 6 (at the point where it is cut by the index line of B 7) we find, very nearly*, the apex of one of the external backwardly-directed V-shaped myocommata. It has been pointed out that an imaginary line joining such apices forms the division between the mesio-dorsal and latero-dorsal portions of the surface area. It is now apparent that any deep continuation of this superficial division must also be guided by expediency; for, internally to our superficial guide-point, we find a <-shaped area (the section of a hollow pyramid), which may be regarded in its entirety as part of a dorsal, posteriorly-directed pyramid, and so of the mesio-dorsal portion of the muscle; or, with equal justice, its lower arm may be regarded as part of the latero-dorsal portion, from the fact that its fibres follow the same direction as those in that portion.

The question to be decided is this: granted that such a division of the lateral muscle is in either case an arbitrary one, is it expedient to frame it in terms of pyramidal masses or in terms of direction of fibres?

Before answering this question let us examine the fissure which divides the mesio-dorsal and the latero-dorsal portions near their anterior origins on the skull. It is found here that all the fibres above the cleft throughout its depth run in the same direction, namely, from above anteriorly to below posteriorly, and that all those below it take the opposite direction. That is to say, when they split apart, the two portions are not divided according to their pyramidal structure, but according to the direction of their fibres; and this fact indicates that the division of the dorsal moiety of the lateral muscle into a mesio-dorsal longitudinal mass and a latero-dorsal longitudinal mass can most naturally be framed in terms of the direction of its component fibres.

In text-fig. 3, B it has been pointed out that the index-line to the 7th myomere cuts the skin approximately at a point in the superficial line of division of the mesio-dorsal and latero-dorsal portions. From this point inwards a zigzag line has been drawn to indicate the arbitrary internal division-plane between the mesio-dorsal and latero-dorsal portions; above this plane the fibres are inclined upwards and forwards, below it they are inclined downwards and forwards. In A the superficial division can be found by bisecting the line of skin between the two portions of the myocomma which encloses the 6th myomere; from this point the internal division-plane can be traced as in B.

It will now be realised that by somewhat devious paths we have reached Gegenbaur's position with regard to the structure of the dorsal moiety of the lateral muscle (*cf.* p. 320). Our arbitrary division leaves us with a series of incomplete cones, or

* In the section next in front of this the apex of the sixth myomere is actually in the surface.

rather pyramids, whose apices are directed backwards, and, below them, a series of complete pyramids whose apices are directed forwards.

The incomplete pyramids correspond externally with Humphry's mesio-dorsal portion, and the complete pyramids with his latero-dorsal portion. For descriptive purposes this division of the dorsal moiety (which is equally applicable to the ventral moiety) has its uses. At the same time one cannot insist too strongly on the fact that its morphological basis is only slightly more secure than that on which Humphry and Maurer framed their two-layer hypothesis; both views depend upon the direction of muscle-fibres, but the former derives certain additional support from an investigation of the muscles in their most anterior region.

The apices of the ventrally-directed pyramids do not always rest against the vertebral centra, but in some Teleosteans (*Scomber*, *Trigla*) they originate in the midst of the muscle-mass. In this case the pyramids become converted into true cones, and in section they appear as a series of concentric circles. In rarer instances (*Conger*) the apices of the dorsal backwardly-directed pyramids are also similarly situated, and in a section of the dorsal moiety of the lateral muscle two superimposed series of concentric circles appear.

SUMMARY.

1. The body-wall of a Teleostean fish is composed on either side of a series of transverse muscles (myomeres) divided from one another by fasciæ of connective-tissue (myocommata).

For practical purposes these may be regarded collectively as forming a single lateral muscle.

2. The lateral muscle is composed of a single layer, which varies considerably in thickness in different parts of the body.

3. In its primary condition, such as obtains in the caudal region, it is divided into two symmetrical longitudinal moieties, which are separated by a horizontal septum passing from beneath the lateral line to the vertebral column.

4. The dorsal moiety is marked externally by a series of backwardly directed >-shaped bands. By joining the apices of these >'s an imaginary line is formed dividing the dorsal moiety into a (dorsal) mesio-dorsal portion and a (ventral) latero-dorsal portion. In the mesio-dorsal portion the muscle-fibres run from above anteriorly to below posteriorly; in the latero-dorsal portion they take the opposite inclination.

Internally the mesio-dorsal portion is recognised as a series of incomplete hollow pyramids, or cones, whose apices are directed posteriorly; while the latero-dorsal portion is composed of a series of complete hollow pyramids, or cones, whose apices are directed forwards.

The ventral moiety is likewise divided into a (dorsal) latero-

ventral portion and a (ventral) mesio-ventral portion: The fibres of the latter, at first oblique, as they approach the middle line become straight, and resemble a rectus.

5. The above divisions of the dorsal and ventral moieties suffice for descriptive purposes; but, pending further evidence, they must be regarded as essentially empirical in nature.

6. Small cylindrical longitudinal muscles are frequently cut off from the mesio-dorsal portion, along the mid-dorsal line in the interspaces of the dorsal fins. These are the supracarinales of Owen.

Similar muscles are frequently cut off from the mesio-ventral portion along the mid-ventral line. These are the infracarinales of Owen.

7. A small muscle, whose fibres are usually distinguished by their red colour, is cut off from the latero-dorsal portion and occupies the slope of the furrow in which the lateral nerve is situated.

A corresponding muscle is cut off from the latero-ventral portion immediately below the lateral line.

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23. Note on *Aristeus goldiei* Macleay, and on some other Fishes from New Guinea. By C. TATE REGAN, M.A.

[Received March 17, 1914: Read April 21, 1914.]

(Text-figures 1 & 2.)

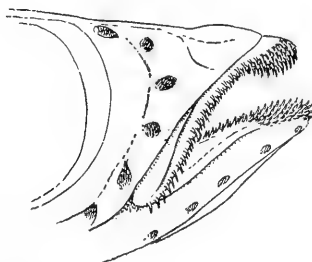
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Mr. A. R. McCulloch, of the Australian Museum, has very kindly sent me some notes on the types of *Aristeus goldiei* Macleay, accompanied by some drawings, which are here reproduced. These leave no room for doubt that this is the species that I have recently described as *Rhombosoma novæ-guineæ* Rams. & Ogilb. (Regan, Trans. Zool. Soc. xx. p. 283, 1914); as Macleay's name has precedence the species should be named *Rhombosoma goldiei*.

According to Mr. McCulloch the types, from the Goldie River, New Guinea, are ten in number and measure 44 to 86 mm. in total length. The dorsal rays number V-VI, I 13-14, the anal rays I 21-24 and the scales in a longitudinal series 34 or 35.

Text-figure 1.



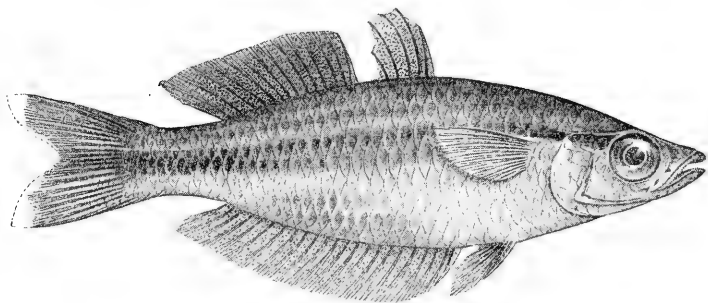
Rhombosoma goldiei: mouth, four times natural size

The depth of the body varies from $3\frac{1}{3}$ in the length in the largest specimen to $3\frac{3}{4}$ in the smallest. All are marked alike and appear to have been silvery, with the back darker, a broad dark band from pectoral to caudal, and a black band from shoulder to eye.

Mr. McCulloch tells me that the types of *Nematocentris novæ-guineæ* are mislaid and that the type of *N. rubrostriatus* Rams. & Ogilb. is damaged about the mouth-parts; a figure of the upper

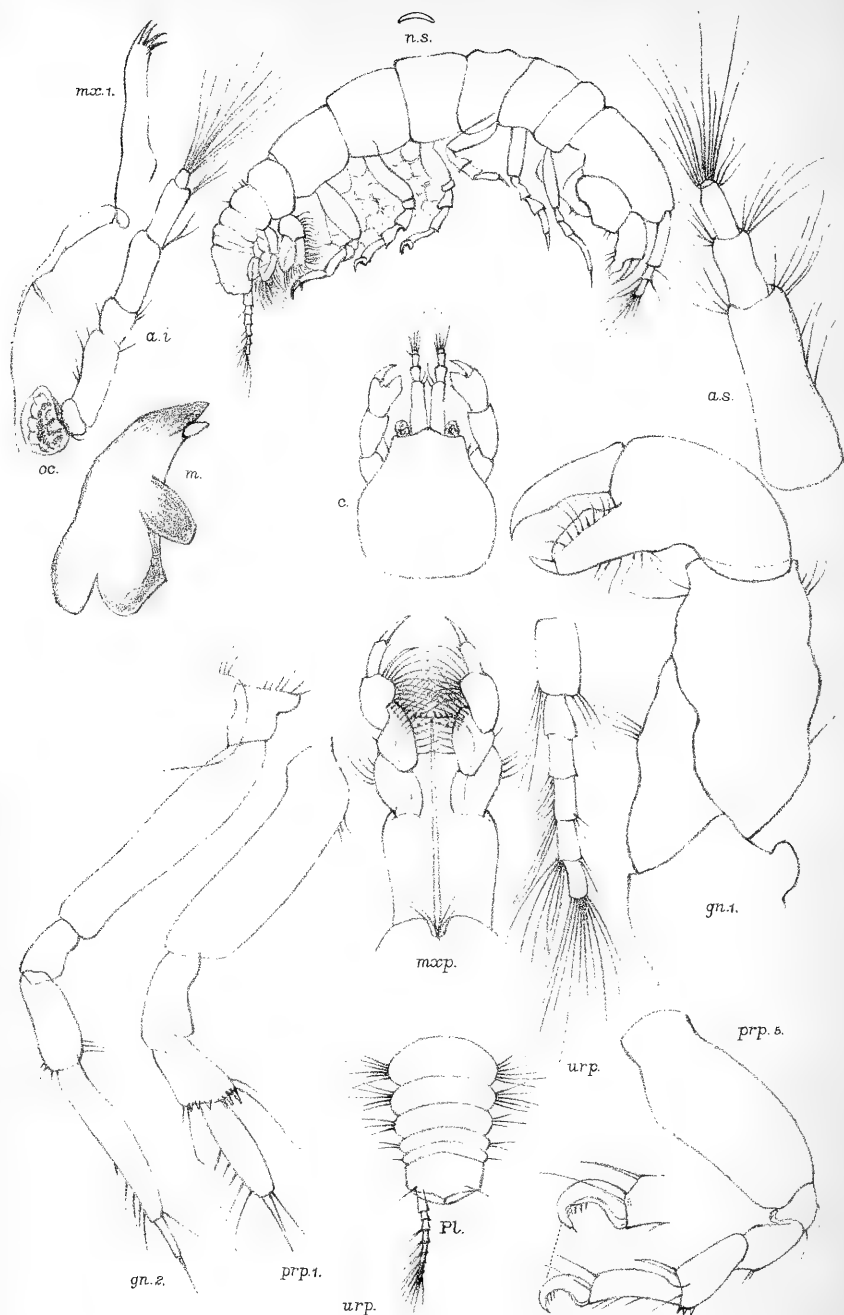
jaw is sufficient to indicate that the examples I have recently described as belonging to this species are correctly determined.

Text-figure 2.



Rhomhosoma goldiei: one of the types, natural size.

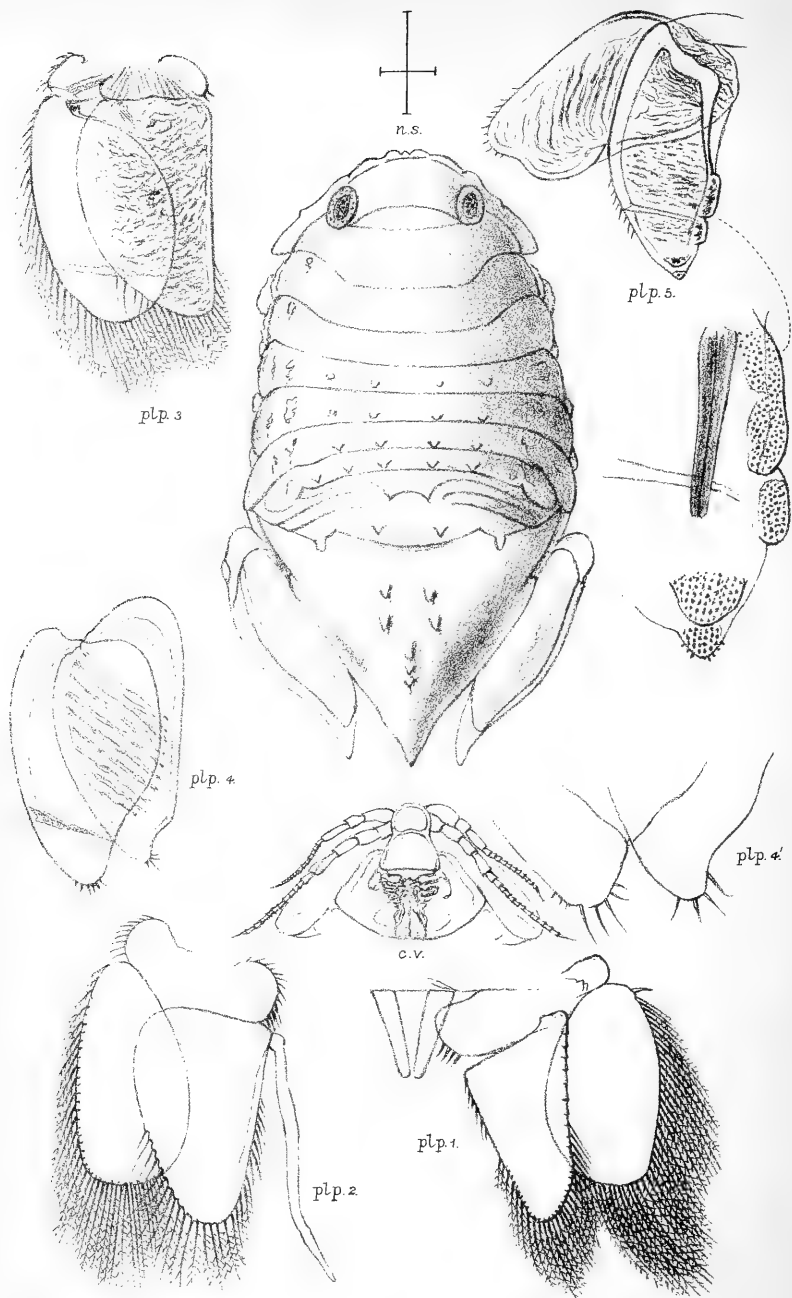
Mr. Douglas Ogilby has written calling my attention to *Dules nitens* (Rams. & Ogilb. Proc. Linn. Soc. N.S. Wales, xii. 1887, p. 4) from New Guinea; there can be little doubt that this is a synonym of *Kuhlia humilis* De Vis (Regan, Proc. Zool. Soc. 1913, p. 380), already known from Queensland and the Fiji Islands.

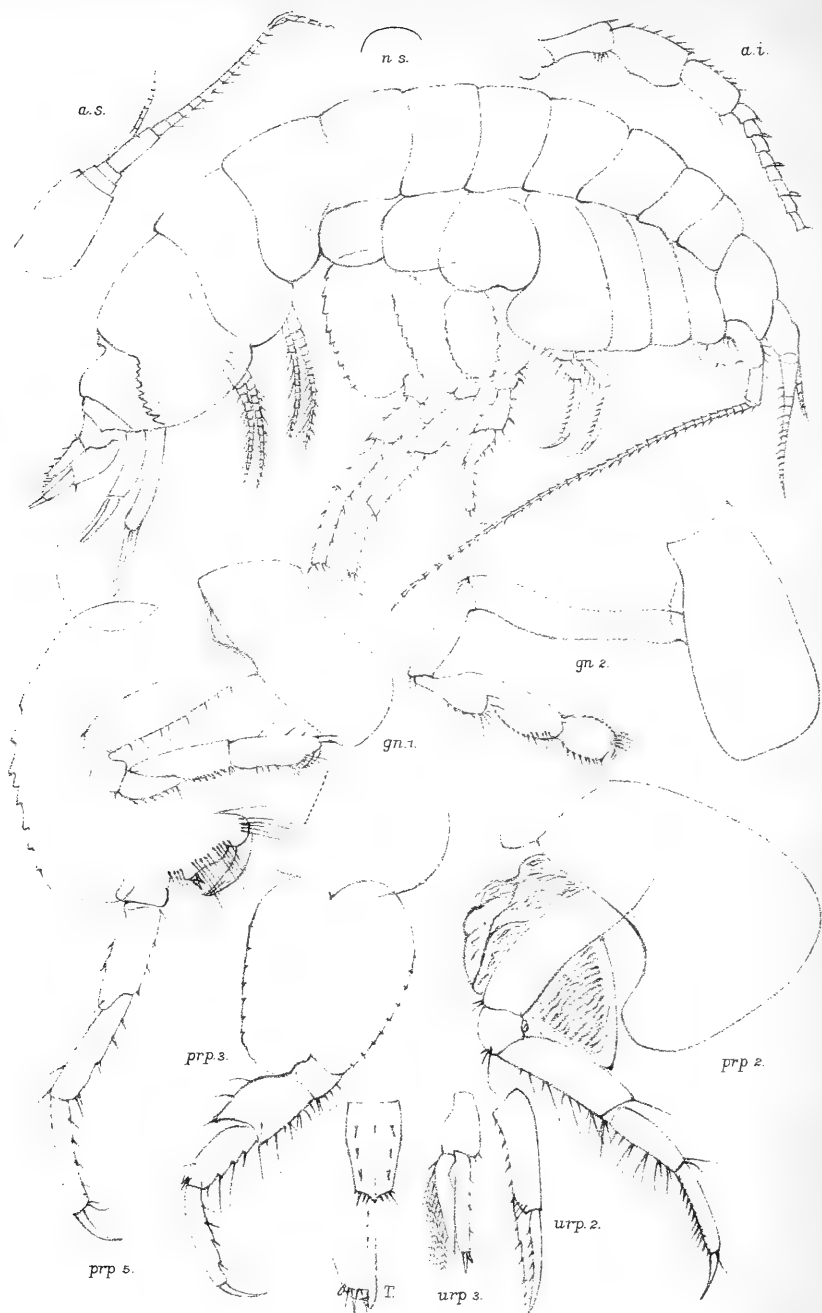


T. R. R. Stebbing, del.

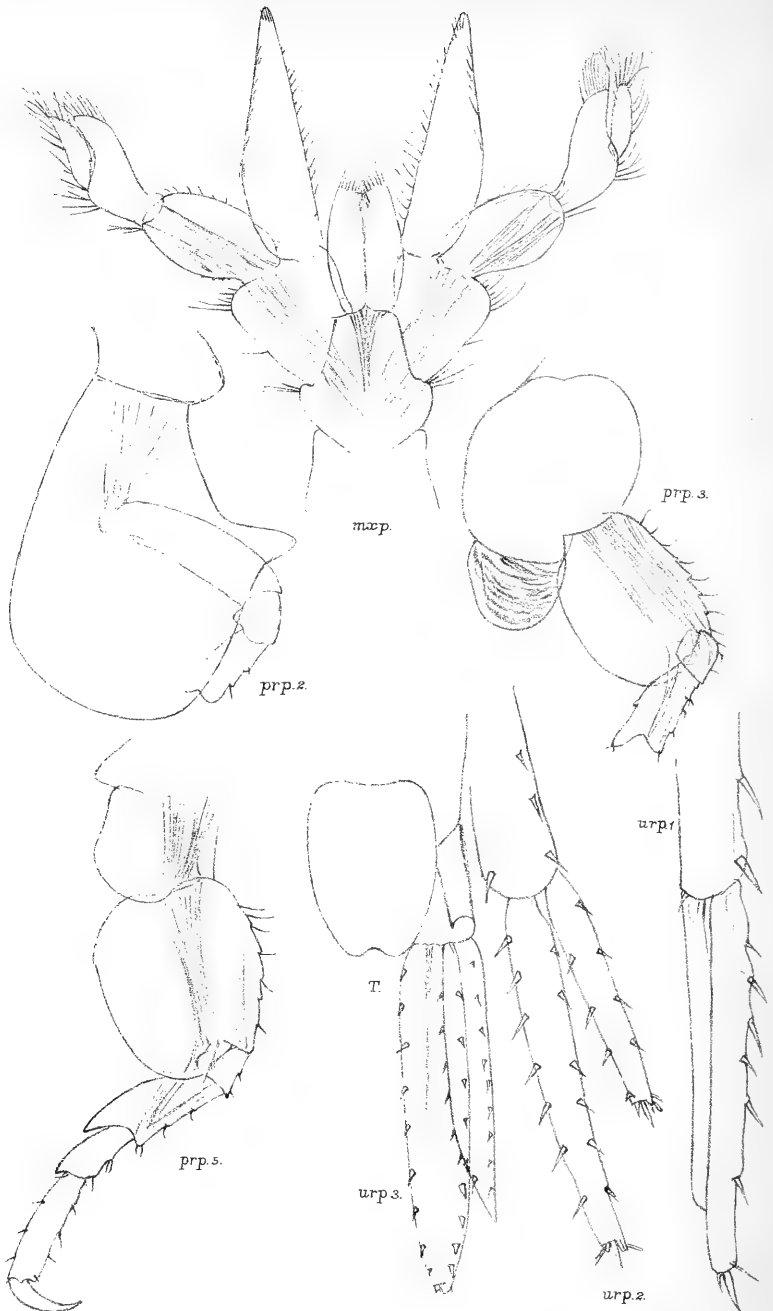
Cambridge University Press.

TANAIS OHLINI, (Stebbing).









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Cambridge University Press.

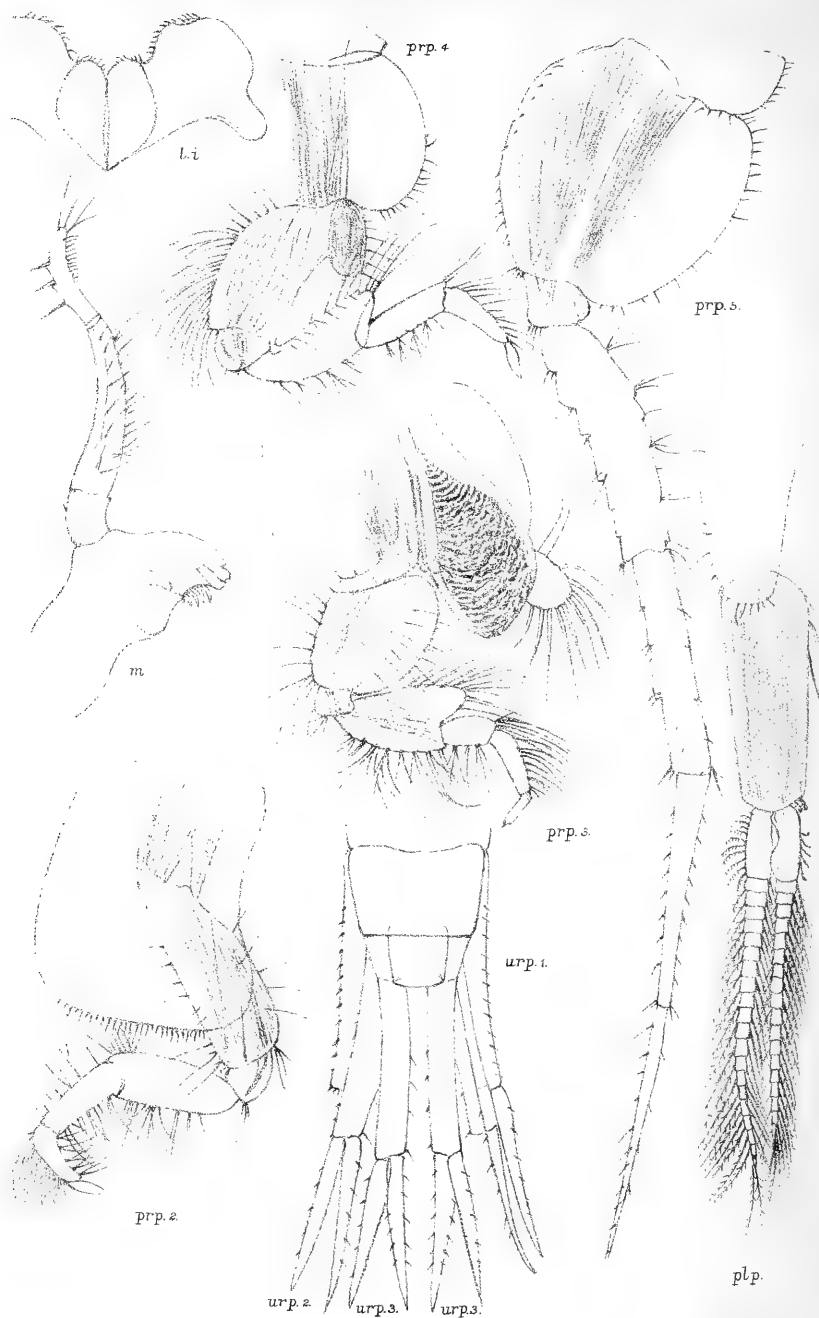
PARIPHIMEDIA NORMANI (Cunningham).



T. R. R. Stebbing, del.

Cambridge University Press.

MONOCULOPSIS VALLENTINI, (Stebbing).

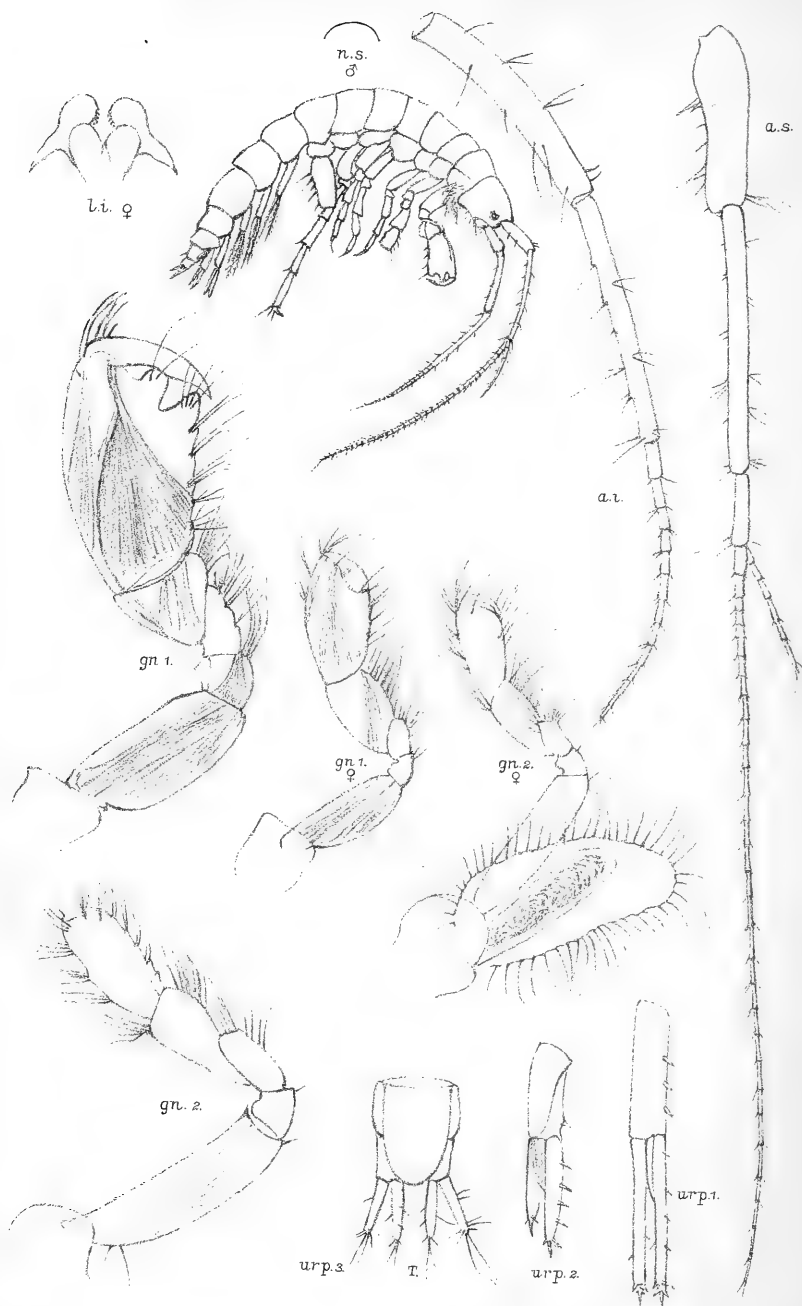




T.R.R. Stebbing, del.

Cambridge University Press.

BOVALLIA REGIS, (Stebbing).



24. Crustacea from the Falkland Islands collected by
Mr. Rupert Vallentin, F.L.S.—Part II. By the Rev.
THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

[Received February 24, 1914: Read April 21, 1914.]

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<i>Iphimedia normani</i> transferred to <i>Pariphiphimedia</i>	359

The record of which this is a continuation was published in the Proceedings of the Zoological Society about fourteen years ago. In the interval Mr. Vallentin has continued his researches during more or less prolonged visits to the Falklands, with the result that very extensive additions have been made to the series of specimens left undescribed in my earlier report.

When Samuel Johnson, in 1771, published his entertaining but politically-minded history of the Falkland Islands, there was naturally no forecast in it that the restless "barren ocean" which breaks on the shores of those wind-swept outposts of civilization would eventually become a happy hunting-ground for students of marine zoology. Nevertheless, as explained in my former paper, the nineteenth century found those waters fruitful in interest. In the present century, while Mr. Vallentin has been waiting with friendliest patience for my further account of his unwearied and still unexhausted researches, the rush to the Antarctic has incidentally brought the island fauna into renewed prominence. As the following discussion will show, it has engaged the attention of numerous eminent carcinologists, such as Chilton, Hansen, Ohlin, Ortmann, Thomas Scott, Tattersall, and Thiele. The present paper proposes one new generic name and five new species †; but Mr. Vallentin's collection has made possible a reconsideration of various forms already known by name, though very imperfectly known by nature. If some useful light has been thrown upon these obscurities, it may perhaps be welcomed as compensation for shortness in the list of novelties, at an epoch when the discovery and display of new species has been almost overwhelmingly rapid.

* For explanation of the Plates see p. 376.

† [The complete account of the five new species described in this communication appears here, but since the names and preliminary diagnoses were published in the "Abstract" No. 132, 1914, these species are distinguished by the names being underlined.—EDITOR.]

The former report dealt with *Peltarion spinosulus* White, *Halicarcinus planatus* (Fabricius)*, *Eurypodius latreillii* Guérin, *Paralomis granulatus* (Jacquinot), *Eupagurus comptus* (White), *Euphausia vallentini* Stebbing, *Thysanoessa macrurus* Sars, *Iais pubescens* (Dana), *Exospheroma gigas* (Leach), *Cassidina emarginatus* Guérin-Ménéville, *Trichoniscus magellanicus* (Dana). Of these the *Eupagurus* reappears under a different specific name, and the species of *Cassidina* has in the interval suffered a generic transfer. Of the specimens not included either in the past list or the present, some are well known. They are reserved, along with others of less obvious character, on the chance that detailed examination, should time and opportunity permit, may yield material for useful comment. In the meantime the following identifications are offered.

MALACOSTRACA.

Brachyura.

Tribe CYCLOMETOPA.

Fam. ACANTHOCYCLIDÆ.

Gen. *Acanthocyclus* M.-Edw. & Lucas.

Acanthocyclus albatrossis Rathbun.

Tribe CATOMETOPA.

Fam. GRAPSIDÆ.

Gen. *Planes* Bowdich.

Planes minutus (Linn.).

Macrura anomala.

Tribe PAGURIDEA.

Fam. PAGURIDÆ.

Gen. *Eupagurus* Brandt.

Eupagurus forceps (Milne-Edwards).

Tribe GALATHEIDEA.

Fam. GALATHEIDÆ.

Gen. *Munida* Leach.

Munida gregarius (Fabricius).

Munida subrugosus (White).

Macrura genuina.

Tribe CARIDEA.

Fam. HIPPOLYTIDÆ.

Gen. *Nauticaris* Bate.

Nauticaris magellanicus (A. Milne-Edwards).

Isopoda anomala or Apseudacea.

Fam. TANAIDÆ.

Gen. *Tanais* Audouin & M.-Edwards.

Tanais ohlini Stebbing.

Isopoda genuina.

Tribe FLABELLIFERA.

Fam. SPHEROMIDÆ.

Gen. *Exospheroma* Stebbing.

Exospheroma calcareus (Dana).

Gen. *Cassidinopsis* Hansen.

Cassidinopsis emarginatus (Guérin-Ménéville).

Vallentinia, gen. n.

Vallentinia darwini (Cunningham).

Tribe VALVIFERA.

Fam. ASTACILLIDÆ.

Gen. *Astacilla* Cordiner.

Astacilla falclandicus Ohlin.

Fam. IDOTEIDÆ.

Gen. *Edotia* Guérin-Ménéville.

Edotia tuberculatus Guérin-Ménéville.

Gen. *Macrochiridothea* Ohlin.

Macrochiridothea stebbingi Ohlin.

Tribe ASELOTA.

Fam. JANIRIDÆ.

Gen. *Notasellus* Pfeffer.

Notasellus sarsii Pfeffer.

* [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature (Proc. 7th Int. Cong. Boston, 1907, p. 44 (1912)).—EDITOR.]

Amphipoda.

Tribe GAMMARIDÆ.

Fam. LYSIANASSIDÆ.

Gen. *Tryphosites* Sars.*Tryphosites chevreuxi* Stebbing.Gen. *Acontiostoma* Stebbing.*Acontiostoma marionis* Stebbing.

Fam. AMPELISCIDÆ.

Gen. *Ampelisca* Krøyer.*Ampelisca macrocephalus* Liljeborg.

Fam. PHOXOCEPHALIDÆ.

Gen. *Pontharpinia* Stebbing.*Pontharpinia rostratus* (Dana).

Fam. METOPIDÆ.

Gen. *Metopella* Sars.*Metopella ovatus* (Stebbing).

Fam. ACANTHONOTOZOMATIDÆ.

Gen. *Iphimedia* H. Rathke.*Iphimedia nodosus* Dana.Gen. *Pariphimedia* Chevreux.*Pariphimedia normani* (Cunningham).

Fam. (EDICEROTIDÆ.

Gen. *Monoculopsis* Sars.*Monoculopsis vallentini* Stebbing.

Fam. CALLIOPIIDÆ.

Gen. *Halirages* Boeck.*Halirages huxleyanus* (Bate).

Fam. PONTOGENEIIDÆ.

Gen. *Bovallia* Pfeffer.*Bovallia regis* Stebbing.Gen. *Pontogeneia* Boeck.*Pontogeneia antarcticus* Chevreux.Gen. *Atylodes* Stebbing.*Atylodes magellanicus* (Stebbing).Gen. *Paramera* Miers.*Paramera austrinus* (Bate).

Fam. GAMMARIDÆ.

Gen. *Melita* Leach.*Melita inæquistylis* Dana.

Fam. DEXAMINIDÆ.

Gen. *Paradexamine* Stebbing.*Paradexamine nanus* Stebbing.

Fam. TALITRIDÆ.

Gen. *Talorchestia* Dana.*Talorchestia scutigerulus* (Dana).Gen. *Hyalella* Smith.*Hyalella patagonicus* (Cunningham).

Fam. AORIDÆ.

Gen. *Lembos* Bate.*Lembos fuegiensis* (Dana).

Fam. PHOTIDÆ.

Gen. *Haplocheira* Haswell.*Haplocheira barbimanus* (Thomson).

Fam. AMPITHOIDÆ.

Gen. *Ampithoe* Leach.*Ampithoe brevipes* (Dana).

Fam. JASSIDÆ.

Gen. *Jassa* Leach.*Jassa falcatus* (Montagu).

Fam. COROPHIIDÆ.

Gen. *Corophium* Latreille.*Corophium cylindricus* (Say).

Fam. PODOCERIDÆ.

Gen. *Podocerus* Leach.*Podocerus brasiliensis* (Dana).

Tribe CYAMIDÆ.

Fam. CAPRELLIDÆ.

Gen. *Caprella* Lamarck.*Caprella penantis* Leach.

Tribe PHRONIMIDÆ.

Fam. HYPERIIDÆ.

Gen. *Hyperia* Latreille.*Hyperia gaudichaudii* Milne-Edwards.

LEPTOSTRACA.

Fam. NEBALIIDÆ.

Gen. *Nebalia* Leach*Nebalia bipes* (O. Fabricius)

THYROSTRACA

Fam. LEPADIDÆ.

Gen. *Lepas* Linn.*Lepas australis* Darwin.

Fam. BALANIDÆ.

Gen. *Elminius* Leach.*Elminius kingii* Gray.

MALACOSTRACA.

BRACHYURA.

Tribe CYCLOMETOPA.

Fam. ACANTHOCYCLIDÆ.

1852. *Cyclinea* Dana, U.S. Expl. Exp. vol. xiii. p. 294.
 1886. *Cyclinea* Miers, Rep. Voy. 'Challenger,' vol. xvii. pt. 49, p. 208.
 1898. *Acanthocyclus* Rathbun, Pr. U.S. Mus. vol. xxi. p. 597.
 1899. *Acanthocyclus* Alcock, J. Asiat. Soc. Bengal, vol. lxviii. pt. 2, p. 96.

Alcock accepts Dana's legion as a subfamily of the Cancridæ, with the definition, "Carapace subcircular: front ending in a triangular point. Epistome short, sunken, completely concealed by the external maxillipeds which also completely cover the buccal orifice. Antennal flagella absent." The second character must be modified for the specimens referred to *A. albatrossis*, as in them the front is not triangular.

Gen. ACANTHOCYCLUS M.-Edwards & Lucas.

1844. *Acanthocyclus* Milne-Edwards & Lucas, D'Orbigny's Voy. Amér. Mérid. vol. vi. pt. 1, p. 30.
 1849. *Acanthocyclus* Nicolet, Gay's Hist. Chile, Zool. vol. iii. p. 176.
 1898. *Acanthocyclus* Rathbun, Pr. U.S. Mus. vol. xxi. p. 597 (with further synonymy).

ACANTHOCYCLUS ALBATROSSIS Rathbun.

1861. *Acanthocyclus gayi* Strahl, Monats. Ak. Wiss. Berlin, July 25, 1861 (1862), p. 713, pl.
 1877. ,, ,, Targioni-Tozzetti, R. Ist. Stud. super. Firenze, vol. i., Crost. della Magenta, p. 95, pl. 7. fig. 1, a-f.
 1898. *A. albatrossis* Rathbun, Pr. U.S. Mus. vol. xxi. p. 599.

Miss Rathbun distinguishes three species of the genus—the original *A. gayi* M.-Edwards & Lucas, 1843, renamed *A. villosus* by Strahl in 1861, Strahl's *A. gayi*, for which preoccupied name *A. albatrossis* is substituted, and *A. hassleri*, discovered by Dr. Faxon, but by his wish described and named by Miss Rathbun, who remarks that "the general appearance of the three species is much the same," but that the differences are constant. Of these eleven are tabulated, and, granting in each case the constancy of the combination, the specific distinction may be justified. Taken separately, many, even most if not all, of the differences relied on, have a rather untrustworthy appearance. Thus the front is entire in *gayi* and *hassleri*, faintly bilobed in *albatrossis*; the dactyli of ambulatory legs are long, little curved in the last, short, much curved in the other two; both carapace and legs are very hairy in *gayi*, less hairy in both the others, which again have the carapace tuberculate, whereas in *gayi* it is almost smooth;

the pleon of the male is narrow in *gayi*, wide in *albatrossis*, intermediate in *hassleri*. Without having specimens from various localities for comparison, it would be presumptuous for me to contest Miss Rathbun's judgment on the matter. I accept the name *albatrossis* for the Falkland Islands specimens, inasmuch as they have the front faintly bilobed, the dactyli long, with a curvature which may be relatively less in a long finger than in a short one, the carapace not very hairy (but at the same time generally smooth except in front), and the fourth joint of the third maxilliped with the outer margin diverging slightly from that of the preceding joint.

The carapace is stated to be in *A. gayi* "narrow; width 1.05 to 1.08 times length"; in *A. albatrossis* "width intermediate, 1.08 to 1.12 times length"; in *hassleri* "wide; width 1.16 times length." In measuring Falkland Islands specimens, I was certainly prejudiced in favour of the name *albatrossis* by finding the measurements respectively, width 1.12 times length of the first example and 1.08 of the second. These were females laden with eggs. Then a male gave width 1.15 times length, with the pleon decidedly narrow. The females laden with eggs vary greatly in size, one specimen measuring 13.5 mm. long, 15 mm. broad, another 23 mm. long, 26 mm. broad. The right cheliped appears to be usually, but not invariably the larger. The ambulatory legs have a dense fringe of hairs, but whether this leaves them less hairy than those of *A. gayi* is matter for comparison.

Locality. Roy Cove, Nov. 12, 1909, and June 16-24, 1910.

Tribe CATOMETOPA.

Fam. GRAPSIDÆ.

1900. *Grapsidæ* Alcock, J. Asiat. Soc. Bengal, vol. lxi. pt. 2, p. 283.

Gen. PLANES Bowdich.

1825. *Planes* Bowdich, Excursions in Madeira and Porto Santo, p. 13, figs. 2a, 2b.

1910. *Planes* Stebbing, Ann. S. Afr. Mus. vol. vi. p. 320.

PLANES MINUTUS (Linn.).

1758. *Cancer minutus* Linn. Syst. Nat. ed. 10, vol. i. p. 625.

It is not surprising that this little wanderer has been taken by Mr. Vallentin at the Falkland Islands, its distribution being very extensive.

MACRURA ANOMALA.

Tribe PAGURIDEA.

Fam. PAGURIDÆ.

Gen. EUPAGURUS Brandt.

1851. *Eupagurus* Brandt, Middendorff's Sibirische Reise, Zool. pt. 1, p. 105.

EUPAGURUS FORCEPS (Milne-Edwards).

1836. *Pagurus forceps* Milne-Edwards, Ann. Sci. Nat., Zool. ser. 2, vol. vi. p. 272, pl. 13. fig. 5.
 1837. " " Milne-Edwards, Hist. Nat. Crust. vol. ii. p. 221.
 1847. *Pagurus comptus* White, Pr. Zool. Soc. London, vol. xv. p. 122.
 1858. *Eupagurus comptus* Stimpson, Pr. Ac. Philad. p. 237 (75).
 1871. *Pagurus forceps*? Cunningham, Tr. Linn. Soc. London, vol. xxvii. p. 495.
 1881. *Eupagurus comptus* Miers, Pr. Zool. Soc. London, p. 72.
 1900. " " Stebbing, Pr. Zool. Soc. London, p. 535.

In now identifying White's species with that described by Milne-Edwards eleven years earlier, I am bound to offer some grounds for my change of opinion. As years pass on, the form known as *E. comptus* is repeatedly collected in the southern parts of South America, and this form agrees well with the description and figure given by Milne-Edwards for his *E. forceps*, with the remarkable exception of the smaller cheliped. This he describes and figures as having the palm extremely short, the fingers slender, long and pointed, the movable finger almost filiform and straight, or even sinuous. There is something so unusual in this character of the smaller cheliped, that, as it does not appear ever to have been observed again, one may be excused for regarding it as an abnormality. It is not at all certain that Milne-Edwards had more than one specimen, though he gives an alternative for the form of the movable finger. He figures it with two slight curves but base and apex in line one with the other. That the species is liable to abnormality may be judged from the figure of the larger cheliped in Zool. 'Erebus' and 'Terror,' Crustacea, pl. 2. figs. 5, 5 a (1874), where the movable finger is evidently stunted. The variability of the species is further shown by the fact that Miers thought it necessary to name a var. *latimanus*, and Henderson a var. *jugosa*.

Mr. Vallentin obtained specimens from *Macrocystis*.

Tribe GALATHEIDEA.

Fam. GALATHEIDÆ.

Gen. MUNIDA Leach.

1820. *Munida* Leach, Dict. Sci. Nat. vol. xviii. p. 52.
 1910. " Stebbing, Ann. S. Afr. Mus. vol. vi. p. 364.

MUNIDA GREGARIUS (Fabricius).

1793. *Galathea gregaria* Fabricius, Ent. Syst. vol. ii. p. 473.
 1891. *Munida gregaria* Mocquard, Miss. Cap Horn, Crustacés, p. 32, pl. 2. figs. 1, 1 a-c.

1902. *Munida gregaria* Benedict, Pr. U.S. Mus. vol. xxvi. p. 308, figs. 45, 46 (with synonymy).
 1911. " " Ortmann, Princeton Univ. Exp. Patagonia, p. 659.

Specimens of various sizes which I refer to this species were taken by Mr. Vallentin Jan. 28, 1899 (at the surface), Dec. 4, 1901, in Roy Cove, Feb. 1, 1910, and in Whales Bay, March 11 of the same year.

MUNIDA SUBRUGOSUS (White).

1847. *Galathea subrugosa* White, List of Crust. Brit. Mus. p. 66.
 1852-5. *Munida subrugosa* Dana, U.S. Expl. Exp. vol. xiii. p. 479, pl. 30. fig. 7 a-c.
 1891. " " Mocquard, Miss. Cap Horn, Crustacés, p. 36, pl. 2. figs. 2, 2 a-c.
 1909. " " Chilton, Subantarctic Is. of N. Zealand, p. 612 (with synonymy).
 1911. " " Ortmann, Princeton Univ. Exp. Patagonia, p. 659.

Dr. Chilton discusses the question of the specific identity of *M. subrugosus* and *M. gregarius*, in which he definitely inclines to believe, though still adopting the later name for the species. As to the generic name, *Grimothea* Leach, 1820, seems to have page precedence over *Munida*, but I forbear the dangerous task of arbitrating between the rival nymphs.

Mr. Vallentin took *M. subrugosus* at a depth of 4 fathoms in Whales Bay, 6 fathoms in Roy Cove, and Dec. 12, 1909, in "8 fathoms creek." All these specimens were adult, and all but one of rather large size.

MACRURA GENUINA.

Tribe CARIDEA.

Fam. HIPPOLYTIDÆ.

1888. *Hippolytidæ* Bate, Rep. Voy. 'Challenger,' vol. xxiv. p. 576.

Gen. NAUTICARIS Bate.

1888. *Nauticaris* Bate, Rep. Voy. 'Challenger,' vol. xxiv. p. 577.

Having already noticed this genus in another (as yet unpublished) paper, I refrain from further discussion here.

NAUTICARIS MAGELLANICUS (A. Milne-Edwards).

1891. *Hippolyte magellanicus* A. Milne-Edwards, Miss. Cap Horn, Crustacés, p. 46, pl. 5. figs. 2, 2 a-i.

This species was taken by Mr. Vallentin from root of *Macro-*

cystis on Dec. 29, 1910, and at various other dates, by hand-net from bed of *Macrocystis* in Roy Cove, from a depth of between 3 and 4 fathoms, and in the same locality two specimens from a depth of 6 fathoms, on which he notes that one was banded red and chocolate in colour, and the other cream-coloured with chocolate markings.

ISOPODA ANOMALA

(or Apseudacea).

1902. *Isopoda anomala* Stebbing, S. African Crustacea, pt. 2, p. 48.
 1910. " " Stebbing, Ann. S. Afr. Mus. vol. vi. pp. 413, 576.

Fam. TANAIIDÆ.

1905. *Tanaidæ* H. Richardson, Bull. U.S. Mus. no. 54, p. 3.
 1905. " Stebbing, Herdman's Pearl Fish. Rep., no. 23, p. 2.
 1913. " Nierstras, Siboga-Expeditie, Mon. 32 a, p. 20.

The last of these references supplies an ample bibliography of the Apseudacea. In my own treatise above mentioned, on p. 4, I attribute to Sars the statement that in his genus *Heterotanaïs* the palp of the first maxilla is terminated by a single seta, a mistake for which I cannot account, as he distinctly states that there are two setæ. The distinction which he does in fact draw is that in *Tanaïs* the palp is biarticulate and tipped with several setæ, but in *Heterotanaïs* uniarticulate with the setæ only two. These minute features have been so seldom attended to in descriptions, that they are difficult to use for the settlement of genera. It might be convenient to withdraw from *Tanaïs* those species which have six separate pleon segments instead of only five. But even on this point authors are not always as definite as could be desired. The species about to be described belongs clearly to the group in which the pleon has six separate segments. As in *Tanaïs*, it has only three pairs of pleopods. Its form is robust like that of *T. robustus* Moore, but while that species has seven setæ on the palp of the first maxilla, this has only two. It shows points of agreement with the much smaller *T. seurati* Nobili, 1906-1907, but there the second joint of the second antennæ is much shorter than the first, here the reverse is the case.

The late Dr. Nobili in 1907 gives the family name as Tanaididæ. As, however, the genitive case of *Tanaïs*, in Latin, is the same as the nominative, it can scarcely be necessary to alter the accustomed form.

Gen. TANAIS Andouin & M.-Edwards.

1829. *Tanais* Andouin & Milne-Edwards, Précis d'Entomologie, vol. i. p. 46, pl. 29. fig. 1.

TANAIIS OHLINI Stebbing. (Pl. I.)

Abstract P. Z. S. 1914, p. 30. (April 28.)

The segments of the pleon successively decrease in length to the sixth, which is longest of all, the curve of its hind margin slightly extended at the middle; the fourth and fifth segments much the shortest.

The eyes are irregularly ovoid, bluntly narrowed forward, the front margin of the head between them not clearly made out. First antennæ with third joint a little shorter than second, and less than one third as long as the first; flagellum consisting of a minute joint, broader than long, with fascicle of setæ. Second antennæ more slender and a little shorter than the first; first joint shorter than third, which is a little over half the fifth, fifth rather shorter than fourth, fourth than second; flagellum one little joint with fascicle of setæ. One of the mandibles has a small tooth-like accessory plate. Whether the palp of the first maxillæ is divided into two joints or not, could not be made out; one of its apical setæ is very much longer than the other. The maxillipeds have an unguis-like spine or fifth joint at the apex.

The large first gnathopod is of the ordinary type, the movable finger rather longer than the thumb, the apical points of the two curving one towards the other; inner margin of the thumb thin, not continuous with that of the apex, and flanked with setules. The slender second gnathopods have the antepenultimate joint not distally widened and without spines, the next joint very much longer, with needle-like finger half its length. The two following pairs of peræopods have the antepenultimate joint distally widened, only a little shorter than the following joint, and distally fringed with small spines, the hand and finger similar to those of the second gnathopod but shorter. The three succeeding pairs of peræopods have the second joint robust, the hand not longer than the wrist, slightly curved, the finger sickle-shaped, with four little spines or teeth on the concave margin near the apex. The marsupium on the penultimate segment of the peræon was crowded with rather large eggs. The pleopods are as usual strongly setose. The uropods are six-jointed, the largest joint constituting the peduncle, the five small joints of the single ramus being, except the first, plentifully furnished with setæ.

Length estimated at 4.5 mm., supposing the body to be flattened out.

Locality. Roy Cove at low spring tide.

The specific name is given in memory of the late Dr. Axel Ohlin, whose valuable researches in the Falkland Islands have only been in part reported on, death having interfered with the fulfilment of his plans.

ISOPODA GENUINA.

Tribe FLABELLIFERA.

Fam. SPHÆROMIDÆ.

1847. *Sphæromidæ* White, List of Crustacea in Brit. Mus.,
p. 102.
1910. „ Stebbing, Ann. S. Afr. Mus. vol. vi. p. 426.

Gen. EXOSPHEROMA Stebbing.

1900. *Exosphæroma* Stebbing, Pr. Zool. Soc. London, p. 553.
1905. „ Hansen, Quart. J. Microsc. Sci. vol. xlix.
pp. 103, 118.
1910. „ Stebbing, Ann. S. Afr. Mus. vol. vi. p. 428.

This genus is placed by Hansen in the section Sphæromini of his group Sphærominæ hemibranchiatæ.

EXOSPHEROMA CALCAREUS (Dana). (Pl. II.)

- 1853-55. *Spheroma calcarea* Dana, U.S. Expl. Exp. vol. xiii.
p. 776, pl. 52, fig. 2 a-c.
1891. *Sphæroma* „ Dollfus, Miss. du Cap Horn, Crust.
p. 64, pl. 8 a. figs. 7, 7 a, 7 b.
1913. *Exosphæroma coatsii* Tattersall, Tr. R. Soc. Edinb. vol. xlix.
p. 885, figs. 3, 4.

This is one of the species which are now in rapidly increasing number perplexing the systematist by their variability. A comparison of the figure supplied by Dana in 1855 with Dr. Tattersall's in 1913 would scarcely suggest a suspicion of specific identity. As it is, probably some allowance must be made for a little want of detail in Dana's sketch. But Dollfus, who had at command several specimens, explains that the granules and tubercles on the general surface and the double crest on the pleon sometimes disappear, leaving a smooth form such as Dana represents. Dr. Tattersall, describing and figuring an adult female and a young form, from Dr. Bruce's Scottish Antarctic Expedition, noted the comparative infrequency of tubercles in the young, with other differences, but he had no mature male to test for sexual difference. This deficiency I have been able to supply from Mr. Vallentin's collections. The specimen figured was 13 mm. long by 7 mm. broad. A female, 16 mm. long, containing a great number of eggs, was taken by Mr. Vallentin at low ebb of a spring tide in Stanley Harbour, Nov. 12, 1901. Other specimens, taken at Rapid Point, low water, Jan. 30, 1911, comprise a male 19 mm. long by 10 mm. broad at the sixth pereon segment. This capture corroborates the statement by Dollfus that he had observed males which were strongly granular and others almost smooth. Variation also affects the colour, at least to judge by preserved specimens,

some being a uniform brown, while others long retain signs of a brilliant marbling, such as that suggested by Dana of purple patches on a yellow ground.

Gen. CASSIDINOPSIS Hansen.

1905. *Cassidinopsis* Hansen, Quart. J. Microsc. Sci. vol. xlix. pp. 77, 82, 87, 90, 94, 106, 109, 128, 130.

Hansen places this genus in his group *Sphærominæ eubranchiatæ*, with the definition, "Head small, narrow in proportion to largest breadth of thorax. Basal joint of antennulæ without process from the distal posterior angle. End of abdomen feebly emarginate. Uropoda similar in both sexes; endopod laterally expanded, very much broader and a little longer than exopod. Both sexes similar, without processes; female with normal mouth-parts and the brood in internal pouches." He states that "the type is *Cassidina emarginata* (Guér.), which in many important points—structure of plp.⁴ and plp.⁵, shape of epistome, mandibles, fifth joint of maxillipeds, end of abdomen—differs strongly from the type for the genus *Cassidina*, *C. typa* (M.-Edw.)."

CASSIDINOPSIS EMARGINATUS (Guérin-Ménéville).

- | | | |
|-------|-----------------------------|---|
| 1843. | <i>Cassidina emarginata</i> | Guérin - Ménéville, Icon. Règne Animal, Crust., texte, p. 31. |
| 1900. | " " | Stebbing, Proc. Zool. Soc. London, p. 562 (with synonymy). |
| 1905. | <i>Cassidinopsis</i> " | Hansen, Quart. J. Microsc. Sci. vol. xlix. p. 87. |
| 1910. | " " | Hodgson, Nat. Antart. Exp. vol. v. p. 4. |
| 1911. | <i>Cassidina</i> " | Ortmann, Princeton Univ. Exp. Patagonia, vol. iii. p. 650. |

The pigmented portion of the eyes has a conical shape, the narrow end foremost. Mr. Vallentin at various dates obtained specimens of different sizes, especially at Roy Cove, from fronds of *Macrocystis* between 2 and 4 fathoms.

VALLENTINIA, gen. nov.

A member of the *Sphærominæ eubranchiatæ*, near to *Paracerceis* Hansen, 1905, but distinguished by not having the basal joint of the first antennæ produced into an acute process, the mandibles of the female not coalesced with the head, the exopod of the uropods much shorter and narrower than the endopod, first gnathopod prehensile in the male.

VALLENTINIA DARWINII (Cunningham).

1871. *Cymodocea darwinii* R. O. Cunningham, Tr. Linn. Soc. London, vol. xxvii. p. 499, pl. 59. figs. 1, 1 a, 1 b.

- ✓ 1881. *Dynamene darwinii* Miers, P. Z. S. Lond. p. 79.
 ✓ 1884. *Cymodocea darwinii* Studer, Abh. K. Ak. Wiss. Berlin,
 1883, p. 18, pl. 2. figs. 6, 6 a, 6 b.
 ! 1886. „ *darwinii* Beddard, Rep. Voy. 'Challenger,'
 vol. xvii. pt. 48, p. 150.
 ✓ 1891. „ *darwinii* Dollfus, Miss. Cap Horn, Crustacés,
 p. 65, pl. 8. figs. 8, 8 a, 8 b.
 ! 1911. „ *darwinii* Ortmann, Princeton Univ. Exp.
 Patagonia, p. 649.

Hansen in his treatise on the Sphaeromidae is evidently alluding to this species when he says (p. 125), "According to kind information from Dr. Calman, *D. Darwinii* (Cunningham) has exopod of plp.³ divided by an articulation; the species must, in my opinion, be established as a new genus near *Paracerceis*." On this recommendation I have acted, naming the genus after Mr. Vallentin, to whose researches I owe the opportunity of examining the species. An interesting feature is the dilatation at the fifth pereon segment, well marked in Cunningham's figure, and noticed by Dollfus but scarcely appreciable in his coloured drawing of an example 19 mm. long. The specimen I have had under observation measured only 9 mm. The apical emargination of the telsonic segment is squared at the base. The epistome is not like the figure given by Dollfus; it widens much more abruptly backwards, and then narrows before forming the divergent arms which clasp the upper lip. The mouth-organs are much as in *Cymodoce*. The first antennæ have a very large first joint followed by a short one, to which succeeds one that is long and slender. The first gnathopods are rather robust, but as Dollfus notices, the large tooth produced from the base of the hand is no doubt a male character, giving to that sex in this genus a pair of prehensile hands.

In his eubranchiate group Hansen makes an informal separation between the genera which have and those which have not an articulation of the exopod in the third pleopod. In the present species the articulation is very conspicuous, through the strong incurving of the inner margin of each joint at the junction; the exopod itself is unusually narrow. The fourth and fifth pleopods, in accord with their systematic position, have both rami strongly pleated. There are five of the denticulate bosses on the end of the exopod in the fifth pair; the exopod of the fourth pair is clearly two-jointed.

Locality. Stanley Harbour, low water.

Tribe VALVIFERA.

Fam. ASTACILLIDÆ.

1897. *Astacillidæ* Sars, Crustacea of Norway, vol. ii. p. 88.
 1901. „ Ohlin, Svenska Exp. Magellanslând. vol. ii.
 p. 265.

Gen. *ASTACILLA* Cordiner.

1795. *Astacilla* Cordiner, Remarkable Rivers, and Nat. Hist.,
Section "Astacillæ."
1905. „ Stebbing, Herdman's Pearl Fish. Rep., Suppl.
Rep. 23, p. 46.

ASTACILLA FALCLANDICUS Ohlin.

1901. *Astacilla falclandica* Ohlin, Svenska Exp. Magellanslând.
vol. ii. p. 266, pl. 20. fig. 1.

I have very little doubt that Ohlin's *Astacilla magellanicus* is a synonym of this species. Mr. Vallentin's specimens were obtained in the Falklands from hulks at low water. The first antennæ have a few filaments in an apical group. The first peræon segment is completely coalesced with the head, and the rather compact little first gnathopods are so attached that they can scarcely have any function but that of mouth-organs. The slender second gnathopods and first two pairs of peræopods have the natatory setæ not at all densely crowded; they have a minute hooked spine as representative of the seventh joint. The hind peræopods are robustly uncinatæ. The length of the body is between 4 and 5 mm.

Fam. *IDOTEIDÆ*.

1852. *Idoteidæ* Dana, Amer. Journ. Sci. ser. 2, vol. xiv. p. 300.
1911. „ Tattersall, Nordisches Plankton, vol. iii. p. 216.

Gen. *EDOTIA* Guérin-Ménéville.

1843. *Edotia* Guérin-Ménéville, Icon. Règne Animal, p. 34.
1901. *Edotia* Ohlin, Svenska Exp. Magellanslând. vol. ii. p. 292.

EDOTIA TUBERCULATUS Guérin-Ménéville.

1843. *Edotia tuberculata* Guérin-Ménéville, Icon. Règne Animal,
p. 34.
1901. „ „ Ohlin, Svenska Exp. Magellanslând.
vol. ii. p. 292, pl. 23. figs. 10, 10A-C, etc.

The synonymy, characters, and distribution of this species are well discussed by the late Dr. Axel Ohlin. More recently it is noted by Ortmann and Hodgson. Mr. Vallentin took specimens in Roy Cove, from a depth of between 3 and 4 fathoms.

Gen. *MACROCHIRIDOTHEA* Ohlin.

1901. *Macrochiridothea* Ohlin, Svenska Exp. Magellanslând.
vol. ii. pp. 282, 286.

The great development of the first gnathopods in both sexes

is referred to in the name of the genus, which also alludes to its alliance in various other respects with *Chiridotea* Harger. As in that genus, the so-called palp of the maxillipeds is three-jointed, but alike in *C. cæcus* (Say) and *C. tuftsii* (Stimpson) the first joint of the palp is much the shortest, whereas in the two species of Ohlin's genus that proportion belongs to the third joint.

MACROCHIRIDOTHEA STEBBINGI Ohlin.

1901. *Macrochiridotea stebbingi* Ohlin, Svenska Exp. Magelansländ. vol. ii. p. 289, fig. 9.

The species has been amply described and figured by Dr. Ohlin from a female specimen, 7 mm. long. Mr. Vallentin obtained a specimen 15 mm. in length, another 14 mm., both 6·5 in breadth, and a third of nearly the same length as the second. As these all happened to be females, there was no opportunity of comparing the male appendix with that of Ohlin's other species, *M. michaelsonii*, of which he gives the measurements as "length of males 11·5 mm.; breadth 5·5 mm. Female smaller."

Locality. Port Harriet, low-water mark spring-tide.

Tribe ASELOTÆ.

Fam. JANIRIDÆ.

1897. *Ianiridæ* Sars, Crustacea of Norway, vol. ii. p. 98.

1901. *Janiridæ* Richardson, Pr. U.S. Mus. vol. xxiii. pp. 497, 550, 553.

1905. „ Stebbing, Herdman's Pearl Fish. Rep., Suppl. Rep. 23, p. 48.

Gen. NOTASELLUS Pfeffer.

1887. *Notasellus* Pfeffer, Jahrb. wiss. Anstalten Hamburg, vol. iv. p. 85.

1902. „ Hodgson, Nat. Hist. Southern Cross Exp. p. 251.

1905. „ Stebbing, Herdman's Pearl Fish. Rep., Suppl. Rep. 23, p. 53.

1910. „ Richardson, Pr. U.S. Mus. vol. xxxvii. p. 649.

1913. „ Richardson, Deuxième Exp. Antarct. française, Isop. p. 17.

NOTASELLUS SARSII Pfeffer.

1887. *Notasellus sarsii* Pfeffer, Jahrb. wiss. Anstalten Hamburg, vol. iv. p. 85, pl. 7. figs. 5-28.

This species has been very fully described and illustrated by Dr. Pfeffer. Specimens were taken by Mr. Vallentin at Rapid Point, low water, Jan. 30, 1911.

AMPHIPODA.

Tribe GAMMARIDEA.

Fam. LYSIANASSIDÆ.

1874. *Lysianassidæ* Buchholz, Zweite D. Nordpolarf. vol. ii.
p. 299.
1913. " Chevreux, Deuxième Exp. Antaret. française,
p. 87.

Gen. TRYPHOSITES Sars.

1891. *Tryphosites* Sars, Crust. Norway, vol. i. p. 81.
1906. " Stebbing, Das Tierreich, vol. xxi. p. 77.
1911. " Sexton, Ann. Nat. Hist. ser. 8, vol. vii. p. 510.
1912. " Chilton, Tr. Roy. Soc. Edinb. vol. xlviii. pt. 2,
p. 469.

To receive the new species here referred to this genus, its definition must be a little modified, by withdrawal of the statement that the postero-lateral angles of the third pleon segment are acutely upturned, nor does the shape of the hand in the second gnathopod precisely conform with that in the type species. Also the inner ramus of the second uropod is not constricted.

TRYPHOSITES CHEVREUXI Stebbing. (Pl. III.)

Abstract P. Z. S. 1914, p. 30. (April 28.)

The third pleon segment, instead of having the postero-lateral corners upturned with a smooth concave margin above, has the lower half of the postero-lateral margin convex and cut into a serration of nine little teeth. Thus the species is sharply distinguished both from *T. longipes* (Bate & Westwood) and from *Hoplonyx stebbingi* Walker, 1903, which Chilton in 1912 transferred to *Tryphosites*, with the remark, among others, that it "appears to be very close to *T. longipes* of northern seas, differing chiefly in having the peræopoda shorter and stouter and the eyes indistinct." Walker lays some stress upon "the absence of a depression" dorsally in the fourth pleon segment. Such a depression is sometimes masked by the telescoping of the segment. In the new species the depression is very marked.

Eyes obscure or absent. Both pairs of antennæ strongly resembling those of *T. longipes*. Accessory flagellum in first pair of the male 7-jointed, principal with 16 joints, some of which carry small calceoli. Flagellum of second pair not so long as the body, with 32 joints, several of the alternate ones carrying calceoli, decreasing in size on the distal portion. Mouth-organs in close agreement with those of *T. longipes*.

The gnathopods differ from those of the two earlier species in scarcely anything but the hand of the second pair, which is not

quite half as long as the wrist. The peræopods are distinguished chiefly by the strong denticulation of the hind margin in the second joint of the fifth pair; in this and the two preceding pairs the terminal joints are not so long and slender as in *T. longipes*; the fourth joint is rather narrower in the fifth pair than in the two preceding pairs. The branchial vesicles show various proximal folds.

The telson is divided nearly to the base, each division having three submarginal spines, and three apical, of which the central is the longest, with a setule between it and the very small outer spine.

Length of male 9 mm. A second specimen, with flagellum of second antennæ broken, the remainder of seven joints carrying no calceoli and suggestive of a short termination, is probably the female. It measures 6 mm., and like the male is very narrow, with the curved process of the epistome conspicuous.

Locality. Roy Cove, from the depth of 8 fathoms. Specimens from Whales Bay, observed after the above description was written, show the second antennæ a little longer than the first.

The species is named in honour of my friend, M. Edouard Chevreux, a brilliant student of the Amphipoda.

Gen. ACONTIOSTOMA Stebbing.

1888. *Acontiosstoma* Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 709.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 9, 15.

ACONTIOSTOMA MARIONIS Stebbing.

1888. *Acontiosstoma marionis* Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 709, pl. 30.

1893. „ „ Della Valle, F. & Fl. Neapel, vol. xx. p. 786.

1906. „ „ Stebbing, Das Tierreich, vol. xxi. p. 15, text-fig. 4.

1912. „ „ Chilton, Tr. R. Soc. Edinb. vol. xlviii. p. 462.

Mr. Vallentin obtained a specimen from roots of *Macrocystis* on Jan. 14, 1902, and another, 7 mm. long, much more recently at Rapid Point, low water of spring tide. The finding of these specimens in the Falkland Islands increases the probability, with which Professor Della Valle naturally agrees, that my *Acontiosstoma magellanicus* is merely a young form of *A. marionis*.

Fam. AMPELISCIDÆ.

1882. *Ampeliscidæ* Sars, Forh. Selsk. Christian. no. 18, p. 29.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 6, 97, 721.

Gen. AMPELISCA Kröyer.

1842. *Ampelisca* Kröyer, Naturh. Tidsskr. vol. iv. p. 154.
 1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 98, 721.

AMPELISCA MACROCEPHALUS Liljeborg.

1852. *Ampelisca macrocephala* Liljeborg, Öfv. Ak. Förh. vol. ix. p. 7.
 1903. „ „ Walker, J. Linn. Soc. London, vol. xxix. p. 53, pl. 9. figs. 58-61.
 1905. „ „ Holmes, Bull. U.S. Bureau Fish. vol. xxiv. p. 479, text-figs.
 1905. „ „ Paulmier, Bull. New York Mus., Bull. 91, Zool. 12, p. 158, fig. 26.
 1906. „ „ Stebbing, Das Tierreich, vol. xxi. pp. 99, 101.
 1907. „ „ Walker, Nat. Antarct. Exp. vol. iii. p. 18.

It may seem extraordinary that this northern and even arctic species should reappear, as Mr. A. O. Walker has determined, in antarctic waters. It has been taken by Mr. Vallentin at low water at spring tides on a sandy beach in Shallow Bay, Falkland Islands, Jan. 15, 1911. The bright red pigment of the eyes lasts long in preservative fluid.

Fam. PHOXOCEPHALIDÆ.

1891. *Phoxocephalidæ* Sars, Crustacea of Norway, vol. i. p. 142.
 1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 6, 133, 723.

Gen. PONTHARPINIA Stebbing.

1899. *Pontharpinia* Stebbing, Tr. Linn. Soc. London, ser. 2, vol. vii. p. 32.
 1906. „ Stebbing, Das Tierreich, vol. xxi. p. 146.
 1913. „ Chevreux, Deuxième Exp. Antarct. française, Amph. p. 101.

PONTHARPINIA ROSTRATUS (Dana).

- 1853-55. *Urothoe rostratus* Dana, U.S. Expl. Exp. vol. xiii. p. 921, pl. 62. fig. 5 a-p.
 1906. *Pontharpinia rostrata* Stebbing, Das Tierreich, vol. xxi. p. 146.

Chevreux's *Pontharpinia uncinatus* is distinguished by the shorter wrist of the second gnathopods and the upturned posterolateral angles of the third pleon segment, but in many respects, as the eminent French author observes, is a near neighbour of the present species.

Locality. Falkland Islands, low water of spring tide.

Fam. METOPIDÆ.

1899. *Metopidæ* Stebbing, Ann. Nat. Hist. ser. 7, vol. iv. p. 210.
 1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 7, 171, 724.

Gen. METOPELLA, Sars.

1892. *Metopella* Sars, Crustacea of Norway, vol. i. p. 274.

METOPELLA OVATUS (Stebbing).

1888. *Metopa ovata* Stebbing, Rep. Voy. 'Challenger,' vol. xxix.
 p. 764, pl. 44.
 1893. *Metopoides ovatus* Della Valle, F. & Fl. Neapel, pp. 645, 907,
 938.
 1906. *Metopella ovata* Stebbing, Das Tierreich, vol. xxi. p. 183,
 figs. 47, 48.
 1912. „ „ Chilton, Trans. R. Soc. Edinb. vol. xlviii.
 p. 481.

A female specimen, containing five large eggs, measured in its folded posture less than 1 mm. in length.

Locality. Stanley Harbour, on seaweed, at low water of spring tide.

Fam. ACANTHONOTOZOMATIDÆ.

1906. *Acanthonotozomatidæ* Stebbing, Das Tierreich, vol. xxi.
 pp. 7, 210.

Gen. IPHIMEDIA H. Rathke.

1843. *Iphimedia* Rathke, N. Acta Ac. Leop. vol. xx. p. 85.
 1906. „ Stebbing, Das Tierreich, vol. xxi. p. 214.
 1907. „ Walker, Nat. Antarct. Exp. vol. iii. p. 37.
 1910. „ Stebbing, Mem. Australian Mus. vol. iv. pp. 584,
 637.

IPHIMEDIA NODOSUS Dana.

1852. *Iphimedia nodosa* Dana, P. Amer. Ac. vol. ii. p. 217.
 1906. „ „ Stebbing, Das Tierreich, vol. xxi.
 pp. 214, 216.

The identification and fuller description of Dana's species supplied in 1906 were made possible by the specimens which Mr. Vallentin obtained at low water of a spring tide in Stanley Harbour. More recently, Dec. 29, 1910, he obtained a specimen from the root of *Macrocystis*.

Gen. PARIPHIMEDIA Chevreux.

1906. *Pariphimedia* Chevreux, Bull. Soc. Zool. France, vol. xxxi.
 no. 2, p. 39.
 1906. „ „ Chevreux, Exp. Antarct. française, Amphip.
 p. 38.

1910. *Pariphimedia* Stebbing, Mem. Australian Mus. vol. iv.
pt. 2, p. 584.
1912. „ Chilton, Tr. Roy. Soc. Edinb. vol. xlviii.
p. 487.

H. Rathke's *Iphimedia* and G. M. Thomson's *Panoploea*, according to Chevreux, are distinguished from this genus chiefly by the following characters:—the cutting-edge of the mandibles not denticulate, the principal lobes of the lower lip emarginate on the inner edge, the palp of the first maxillæ two-jointed, the inner lobe of the second maxillæ carrying a single series of setæ, the second gnathopod not completely chelate, and the telson apically emarginate.

It would, I think, be inconvenient to press the first of these characters as essential to either of the genera mentioned; but both are rather sharply separated from *Pariphimedia* by the two-jointed palp of the first maxilla, in strong contrast with the feeble single-jointed structure in Chevreux's genus, which makes an approach to that found in *Odius* Lilljeborg.

In adding a second species to the genus, I feel fairly sure that it is identical with the scantily-described *Iphimedia normani* Cunningham, which has so long remained obscure. But the addition tends to weaken the original definition, inasmuch as the telson has a neat little convex emargination which helps to distinguish it from *P. integricauda*, in which, as the specific name declares, the telson is unincised. By a curious contrariety the upper lip, which is there slightly emarginate, is here simply convex. The mandibles in the two species essentially agree, the trunk tapering to a fine point, the distal part of the margin minutely denticulate, the molar represented by a projection with no trituration surface, the palp well developed, its second joint much the longest, the third curved, setose. Neither mandible in *P. normani* has a secondary plate, so far confirming the suggestion which I have earlier made, that the same is the case in *P. integricauda*. While it may be said that the distal lobes of the lower lip are in both species undivided, it will be seen that in *P. normani* there is a marked tendency towards apical division.

PARIPHIMEDIA NORMANI (Cunningham). (Pls. IV. & V.)

1871. *Iphimedia normani* Cunningham, Tr. Linn. Soc. London,
vol. xxvii. p. 498, pl. 59. fig. 7.
1906. „ „ Stebbing, Das Tierreich, vol. xxi. p. 217.

This species, by the notable features of its mouth-organs and gnathopods, clearly belongs to the family Acanthonotozomatidæ. But of spine-like processes on the back, which so many members of that family exhibit, it is singularly devoid. Only the third segment of the pleon makes a show of relationship in this respect by an upturned postero-lateral angle and high up on the side a still stronger upturned tooth. The two preceding segments have the postero-lateral angle produced into acute points, and

the sides angled. The side-plates of the peræon have no acute points except that which forms the boundary of the emargination in the large fourth pair. The fifth pair are bilobed and not produced backwards as in the congeneric species.

The eyes have numerous small components. The flagellum of the first antennæ shows fifteen joints, that of the second twenty-nine, in each case the first joint being much the longest, the second flagellum about a fifth of its length longer than the first. The mandibles and maxillæ are in close agreement with those described by Chevreux, but the maxillipeds differ by the greater length of both the inner and the outer plates, the latter being nearly as long as the palp; a faint transverse line gives them the appearance of being jointed.

The gnathopods, peræopods, and uropods also differ but little from those of the companion species, but the second joint of the first gnathopod is here sinuous, not straight, and the second joint of the third peræopod is here broader, with the hind margin convex.

The specimen, a female with a few large ova, measured about 9 mm., in near agreement with Dr. Cunningham's specimen, 4 lines long, but much less than the specimen of *P. integricauda*, described by Chevreux as 15 mm. in length. The colour as preserved was marbled red.

Locality. Whales Bay, Falkland Islands, May 17, 1910. Cunningham states that his specimen was dredged off Elizabeth Island in February 1867.

Panoploea joubini Chevreux, 1912, strikingly distinguished from the present species by numerous spiniform processes, curiously resembles it in the unemarginate upper lip, long plates of the maxillipeds, emarginate telson, and in the gnathopods.

FAM. *ÆDICEROTIDÆ*.

1906. *Ædicerotidæ*. Stebbing, *Das Tierreich*, vol. xxi. p. 235.

Gen. *MONOCULOPSIS* Sars.

1892. *Monoculopsis* Sars, *Crust. Norway*, vol. i. p. 310.

In many respects this genus agrees with *Monoculodes* Stimpson. Distinguishing features are the considerable size of the fourth and fifth side-plates, the relatively greater length of the third joint of the peduncle in the first antennæ, and the somewhat tapering form of the long sixth joint in the second gnathopods.

MONOCULOPSIS VALLENTINI Stebbing. (Pls. VI. & VII.)

Abstract *P. Z. S.* 1914, p. 30. (April 28.)

From *Monoculopsis longicornis* (Boeck), the type of the genus, the present species is distinguished chiefly by characters of the gnathopods. In the first pair the process of the wrist or fifth

joint, though well pronounced, is very slender and does not reach the palm. In the second pair the process of the same joint, instead of being very long and extending beyond the inner corner of the palm, is very short and quite distant from the palm. Moreover, the first antenna in the female is decidedly shorter instead of a little longer than the second, and it has a flagellum as long as the peduncle instead of one only a little longer than the peduncle's third joint. Here, it may be thought, are materials for establishing a new genus, but that may wait, since the discovery of intermediate forms might easily make it unnecessary.

The organ of vision on the short rostrum is white in the preserved specimens. The first antennæ have the first joint as long as the second and much stouter, the third joint little more than two thirds as long as the second, the flagellum of sixteen joints. In the second antennæ the last joint of the peduncle is longer than the stouter penultimate; the gland-cone of the second joint is blunt-ended; the flagellum is composed of twenty-two joints, but fewer in a smaller specimen.

The trunk of the mandibles has the cutting-edge not strongly dentate, the molar not very prominent, the third joint of the palp much shorter than the setose second, each curved but in opposite directions. The spine-row consists of five spines. The inner plates of the lower lip are distinctly developed. The inner plate of the first maxillæ is tipped with three small setæ; the elongate second joint of the palp has several setæ along the outer margin and six spines on the distal part of the inner. The maxillipeds are like those in the type species.

The oblique palm is longer than the hind margin of the hand in the first gnathopod, but considerably shorter than it in the second. The first and second peræopods are alike. The third and fourth differ from them in the greater expansion of the second joint. The fourth differs from the third by the greater size of its second, fifth, and sixth joints. In all four pairs the sixth joint is notable for the dense clothing of setæ along the back or convex margin of the sixth joint. The small finger is unarmed except for a microscopic unguis. The long fifth peræopods do not appear to be distinctive.

The pleopods have two minute coupling-hooks on the inner distal corner of the peduncle, and five coupling-spines on the first joint of the inner ramus, which is very slightly shorter than the outer. The uropods have their long peduncles successively shorter, in each case longer than their respective rami, which are also long, in the first and second pairs the inner ramus slightly longer than the outer, the spine armature throughout rather slight. The telson scarcely longer than broad, with a minute spinule at each rounded corner of the truncate distal margin.

The female specimen measured 9 mm. across the curve from the rostrum to the end of the third pleon segment, so that if straightened out the full length to the end of the telson might

have been 12 mm., but it is difficult to say what allowance should be made for the telescoping of the segments.

Locality. Top of Roy Cove, low water, Aug. 1, 1910.

Fam. CALLIOPIIDÆ.

1893. *Calliopiidae* Sars, Crust. Norway, vol. i. p. 431.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 285, 727.

Gen. HALIRAGES Boeck.

1871. *Halirages* Boeck, Forh. Selsk. Christian. 1870, p. 194.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 285, 290.

HALIRAGES HUXLEYANUS (Bate).

1862. *Atylus huxleyanus* Bate, Catal. Amph. Brit. Mus. p. 135, pl. 25. fig. 4.

1888. *Halirages huxleyanus* Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 902, pl. 73.

1906. „ „ Stebbing, Das Tierreich, vol. xxi. p. 291.

Mr. Vallentin obtained this species from a nest on *Macrocystis*, Dec. 24, 1898. He also records it from Stanley Harbour, taken by tow-net; he took it from a rock-pool, June 10, 1910, having previously on March 11 of that year found the sea teeming with it.

Fam. PONTOGENEIIDÆ.

1906. *Pontogeneiidae* Stebbing, Das Tierreich, vol. xxi. p. 356.

1913. „ Chevreux, Deuxième Exp. Antarct. française, Amph. p. 167.

Gen. BOVALLIA Pfeffer.

1888. *Bovallia* Pfeffer, Jahrb. Hamburg. Anst. vol. v. p. 95.

1906. „ Stebbing, Das Tierreich, vol. xxi. p. 357.

1909. „ Chilton, Subantarct. Is. of N. Zealand, p. 622.

1912. „ Chilton, Tr. R. Soc. Edinb. vol. xlviii. p. 494.

1913. „ Chevreux, Deuxième Exp. Antarct. française, Amph. p. 168.

In Chilton's paper, 1912, Walker's *Eusiroides orchomenipes*, 1904, is accidentally cited as *E. orchomenopsis*.

BOVALLIA REGIS Stebbing. (Pl. VIII.)

Abstract P. Z. S. 1914, p. 30. (April 28.)

In the medio-dorsal structure the new species strongly resembles *B. giganteus* Pfeffer, and *B. walkeri* (Stebbing), first described by Walker as *Atylus antarcticus*. But it has a character not attributed to these, in that the lower borders of all the

peræon segments are extended laterally outwards over the side-plates. The latter agree with those figured by Walker and Chevreux for *B. walkeri*. The subacute medio-dorsal extension of the last peræon segment and the first two pleon segments is very pronounced, as is that of the third pleon segment, but this last is distinguished from the others by its obtuseness. The second and third pleon segments have the postero-lateral angles minutely acute. The telson has an extremely short division between the subacute apical lobes, which reach a little beyond the peduncle of the third uropod. In both specimens examined the lobes were slightly unsymmetrical.

The eyes are round, not crescentic as in *B. giganteus*, nor large and reniform as in *B. walkeri*. The first antennæ agree with the former only, in having no accessory flagellum; the principal flagellum showed short filaments on the first, second, fourth, and seventh articulations, and so on at each successive third to the twenty-second or twenty-eighth, the total in one specimen being 30, in another 33. The longer second antennæ show a flagellum of 46 joints, the proximal group very short, those towards the end rather long, the whole flagellum longer by half than that of the first pair. Each mandible has an accessory plate, that on the left forming five little teeth, that on the right having only two, which are longer and apical instead of serial; the third joint of the palp is shorter than the second. The lower lip appears to be without inner lobes. The first maxillæ have four plumose setæ on the apical margin of the rather broad inner plate second joint of the palp long.

The first and second gnathopods are extremely similar in the female, the hand oval, narrowest at the finger-hinge, the palm making a continuous curve with the hind margin, its limit defined by spines which the tip of the curved finger reaches; hand and finger slightly larger in the first gnathopod than in the second. The fifth peræopod has the hind margin of the second joint sinuous, the greatest width of the joint being near its base.

The first uropods have a peduncle much longer than the inner ramus, which is longer than the outer, but shorter than the inner ramus of the second pair, that ramus exceeding its peduncle in length. The third uropods have the rami subequal, much longer than their peduncle and somewhat longer than the telson.

Length of one specimen 12 mm., that of the specimen figured 9 mm. in its bent posture, probably about 12 mm. if extended; it contained numerous eggs.

Locality. Low spring tide at Roy Cove, the specific name alluding to that of the place so diligently examined by Mr. Valentin.

Gen. PONTOGENEIA Boeck.

1871. *Pontogeneia* Boeck, Forh. Selsk. Christian. 1870, p. 193.

1906. ,, Stebbing, Das Tierreich, vol. xxi. p. 359.

PONTOGENEIA ANTARCTICUS Chevreux.

1906. *Pontogeneia antarctica* Chevreux, Bull. Soc. Zool. France, vol. xx. p. 79, text-fig. 2 A-K.
 1906. " " Chevreux, Exp. Antarct. française, Amphip. p. 69, text-figs. 40, 41 A-K.
 1909. " " Chilton, Subantarct. Is. of N. Zealand, Art. 26, p. 624.
 1912. " " Chilton, Tr. R. Soc. Edinb. vol. xlviii. p. 796.
 1913. " " Chevreux, Deuxième Exp. française, Amphip. p. 177, text-fig. 59 A-C.

This species by its smooth, compressed, and not dentate body is strikingly distinguished from *Bovallia regis*, which in many other points it nearly resembles.

The specimen which I am here assigning to Chevreux's species agrees admirably in most respects with the French author's figures and description, especially with the figures which he has recently given of the male gnathopods. Of these, the first are larger than the second, the hands in both pairs oval, with the palm scarcely distinguished from the hind margin except by the extent of the respective fingers. The unarmed telson, with short division between the rounded apical lobes, is also in precise agreement. The inner plate, however, of the first maxillæ has only three terminal setæ, instead of the four shown in Chevreux's figure and five mentioned in his text. Also the third uropods have few spines instead of many, and the flagellum of the first antennæ after the first two joints has the filament-bearing joints separated from two to two, not three to three. These differences may well be attributed to an earlier stage in the development, but if so, the last of them would throw doubt on the importance which has been attributed to these intervals in the flagellum of various specimens. In Dana's *Iphimedia simplex* (from Hermite Island), which evidently belongs to this family, the first two filament-bearing joints are the third and sixth, but the following are the eleventh, sixteenth, and so on for each successive fifth joint.

Locality. Stanley Harbour, among seaweed at low water of spring tide.

Gen. ATYLOIDES Stebbing.

1888. *Atyloides* (part) Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 913.
 1906. " Stebbing, Das Tierreich, vol. xxi. pp. 356, 362.
 1909. " Chilton, Subantarct. Is. New Zealand, p. 627.
 1912. " Chilton, Tr. Roy. Soc. Edinb. vol. xlviii, pt. 2. p. 496.

Chilton, in 1909, inclines to identify this genus with *Paramœra*

Miers, 1875, but in 1912 he still retains it, and endows it with a new species, *A. calceolatus*.

ATYLOIDES MAGELLANICUS (Stebbing).

1888. *Atylopsis magellanicus* Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 925, pl. 79.

1906. *Pontogeneia magellanica* Stebbing, Das Tierreich, vol. xxi. p. 360.

1906. " " Chevreux, Exp. Antarct. française, Amph. p. 64, figs. 37-39.

1907. " " Walker, Nat. Antarct. Exp. vol. iii. p. 33, pl. 12. fig. 20.

1909. *Atyloides magellanica* Chilton, Subantarct. Is. of N. Zealand, p. 627.

1912. " " Chilton, Tr. R. Soc. Edinb. vol. xlviii. p. 496, pl. 1. fig. 18.

1913. " *magellanicus* Chevreux, Deuxième Exp. Antarct. française, Amph. p. 178.

The transference of this well-distributed species from genus to genus is at least some testimony that the genera concerned belong to a single family. There is general agreement as to the variability of the telson, to which Mr. Vallentin's collection bears further witness.

Locality. Whales Bay, May 17, 1910.

Gen. PARAMÆRA Miers.

1875. *Paramæra* Miers, Ann. Nat. Hist. ser. 4, vol. xvi. p. 75.

1906. " Stebbing, Das Tierreich, vol. xxi. p. 363.

1912. " Chilton, Tr. R. Soc. Edinb. vol. xlviii. p. 498.

PARAMÆRA AUSTRINUS (Bate).

1862. *Atylus austrinus* Bate, Catal. Amph. Brit. Mus. p. 137, pl. 26. fig. 4.

1906. *Paramæra austrina* Stebbing, Das Tierreich, vol. xxi. p. 363.

1909. " " Chilton, Subantarct. Is. of N. Zealand, p. 625.

1912. " " Chilton, Tr. R. Soc. Edinb. vol. xlviii. p. 498.

Among the specimens which I refer to this species, one had calceoli on fourteen consecutive joints of the flagellum in one of the first antennæ, while in the other the calceoli were only on alternate joints. In another specimen, calceoli were present on alternate joints of both members of the second pair of antennæ, while on the one remaining member of the first they were, if present, very inconspicuous.

Locality. Low water at top of Roy Cove creek, Aug. 1, 1910.

Fam. GAMMARIDÆ.

1814. *Gammaridæ* Leach, Edinb. Encycl. vol. vii. p. 432.

Gen. MELITA Leach.

1813. *Melita* Leach, Edinb. Encycl. vol. vii. p. 403.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 366, 421, 732.

MELITA INÆQUISTYLIS Dana.

1852. *Amphitoë (Melita) inæquistylis* (♀) and *A. (M.) tenuicornis* (♂) Dana, P. Amer. Ac. vol. ii. pp. 214, 215.

1906. *Melita inæquistylis* Stebbing, Das Tierreich, vol. xxi. pp. 429, 732.

1909. „ „ Chilton, Subantarct. Is. of N. Zealand, p. 630.

This species has been rediscussed by Dr. Chilton, who unites with it *Melita zeylanica* Stebbing, 1904, from Ceylon. Mr. Valentin procured a male specimen at low water in Rapid Point, Jan. 20, 1911.

Fam. DEXAMINIDÆ.

1888. *Dexaminidæ* Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 573.

Gen. PARADEXAMINE Stebbing.

1899. *Paradexamine*, Stebbing, Ann. Nat. Hist. ser. 7, vol. iv. p. 210.

1906. „ Chevreux, Exp. Antarct. française, Amphip. p. 88.

1909. „ Chilton, Subantarct. Is. of New Zealand, p. 632.

1910. „ Stebbing, Mem. Australian Mus. vol. iv. p. 602.

1912. „ Chilton, Tr. R. Soc. Edinb. vol. xlviii. pt. 2, p. 501.

1913. „ Chevreux, Deuxième Exp. Antarct. française, Amphip. p. 181.

Professor Chilton proposes to make Chevreux's *P. fissicauda* a synonym of Thomson's *P. pacificus*, although in the latter species the telson is not divided to the base as it is in the former. In 1913 Chevreux observes that his *P. fissicauda* is separated from all the other known forms of the family Dexaminidæ by the second maxillæ, the inner plate of which carries a series of spines on the inner margin.

PARADEXAMINE NANUS Stebbing.

Abstract P. Z. S. 1914, p. 30. (April 28.)

In point of size this species is comparable with *P. flindersi*, from which it is distinguished by the differently-shaped telson and by the greater length of the palp of the maxillipeds. The

body is much less conspicuously dentate than in any other described species of the genus, having a medio-dorsal tooth extended backwards only on the second, third, and fourth pleon segments, this tooth being flanked on the third segment by a very small pair of additional teeth, which may be present also on the second segment but were not perceived. The mouth-organs, both gnathopods, uropods, and telson, are in close agreement with those described and figured by Chevreux for *P. fissicauda*, 15 mm. in length. In the first maxillæ, however, there is only one seta on the narrowly oval inner plate, and few setæ on the single-jointed palp. The inner margin of the inner plate of the second maxillæ could not be made out. The fifth joint in the first gnathopods is not longer than the sixth, but in the other species the difference in length appears to be very slight. In the fourth pereopods the second joint has a convex hind margin, not a sinuous one as in the species compared. The telson does not reach the end of the third uropods, and each of its long narrow lobes has three or four spines along its outer margin with two unequal spinules at the apex. The flagellum of the first antennæ is composed of fourteen joints, that of the second is more slender with nine joints; in both pairs the joints in general being considerably longer than broad. Each of the two specimens measured 2.5 mm. The one dissected contained numerous eggs, and, whatever allowance is made for variability, I think it would be scarcely reasonable to regard this matron, a tenth of an inch long, as belonging to the same species as a congener over thirty times her bulk.

Locality. Stanley Harbour, in seaweed at low water of spring tide.

Fam. TALITRIDÆ.

1906. *Talitridæ* Stebbing, Das Tierreich, vol. xxi. pp. 8, 523, 735.

1913. " G. M. Thomson, Tr. N. Zealand Inst. vol. xlv.
p. 243.

Thomson is "inclined to reduce *Talitrus*, *Talitroides*, *Orchestoidea*, *Talorchestia*, and *Parorchestia* to *Orchestia*." But to play the part of Saturn swallowing his children, he should have chosen *Talitrus* in preference to *Orchestia*. Calman in 1912 agrees with him in questioning the independence of *Talitroides*.

Gen. TALORCHESTIA Dana.

1852. *Talorchestia* Dana, Amer. J. Sci. ser. 2, vol. xiv. p. 310.

1906. " Stebbing, Das Tierreich, vol. xxi. p. 543.

1907. " Chevreux, Mém. Soc. Zool. France, vol. xx.
p. 495.

TALORCHESTIA SCUTIGERULUS (Dana).

1853-5. *Orchestia scutigerula* Dana, U.S. Expl. Exp. vol. xiii.
p. 863, pl. 58. fig. 2.

1862. " " Bate, Catal. Amph. Brit. Mus.
p. 26, pl. 4. fig. 7.

1906. *Talorchestia scutigerula* Stebbing, Das Tierreich, vol. xxi. p. 544.
 1912. „ „ Chilton, Tr. Roy. Soc. Edinb. vol. xlviii. p. 508.

Mr. Vallentin reports this species as very common along the shore at Stanley Harbour, Nov. 20, 1898, and he obtained numbers of smaller specimens from cast up *Macrocystis* on March 21, 1902. One of the largest of these latter measured 13.5 mm. in length, and is in good correspondence with Dana's figure from a Tierra del Fuego specimen. But a larger specimen from Mr. Vallentin's earlier find measured 15 mm., and agrees with Bate's figure, showing the shield at the back of the second joint of the fifth peræopod rising above the animal's back, over which the two bucklers meet. The difference in appearance between the two forms is very considerable, but further comparison shows that it is due to the maturing of the single feature to which it is confined.

Gen. *HYALELLA* S. I. Smith.

1874. *Hyalella* S. I. Smith, Rep. U.S. Fish Comm. vol. ii. p. 645.
 1906. „ Stebbing, Das Tierreich, vol. xxi. p. 574.
 1907. „ Weckel, Pr. U.S. Mus. vol. xxxii. p. 54.
 1906. „ Chevreux, Lacs des hauts plat. d'Amér. du Sud, p. 1 (extrait, 1907).
 1910. „ Weckel, Pr. U.S. Mus. vol. xxxviii. p. 623.
 1911. „ Ortmann, Princeton Univ. Exp. Patagonia, vol. iii. p. 650.

HYALELLA PATAGONICUS (Cunningham) Ortmann.

1871. *Allorchestes patagonicus* Cunningham, Tr. Linn. Soc. London, vol. xvii. p. 498, pl. 59. fig. 4.
 1888. *Hyalella patagonicus* Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 404.
 1911. *Hyalella patagonica* Ortmann, Princeton Univ. Exp. Patagonia, vol. iii. p. 650, pl. 48. fig. 3 a-h.

If the above identification could be proved to be erroneous by comparison with Cunningham's original specimen, a change in the recent specific name would become necessary on the ground of preoccupation. As it stands the species has been amply described as new by Dr. Ortmann, who also mentions its near relationship to other species of the genus. In our specimens the sixth joint of the fifth peræopod is relatively longer than in Ortmann's figure, and the third uropods agree not with his figure, but with his text. Mr. Vallentin reports the "colour when alive very dark brown, almost black."

Localities. "In sand ground near old house, Port North, 10 Aug., 1910." Along with it were numerous specimens of the little Copepod *Boeckella michaelsoni* (Mrázek), of which Dr. Thomas Scott, F.L.S., reports in the Ann. Nat. Hist. ser. 8, vol. viii. p. 3, 1914, "This species occurred in at least eight gatherings"

(of Mr. Vallentin's collection). The *Hyalella* was also "found in a freshwater stream some miles distant from Stanley," where "this species appeared to be fairly common."

Fam. AORIDÆ.

1899. *Aoridæ* Stebbing, Ann. Nat. Hist. ser. 7, vol. iv. p. 211.

Gen. LEMBOS Bate.

1857. *Lembos* Bate, Ann. Nat. Hist. ser. 2, vol. xix. p. 142.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 594, 737.

1909. „ Walker, Tr. Linn. Soc. London, vol. xii. p. 337.

1909. „ Chilton, Subantarctic Is. of N. Zealand, p. 646.

LEMBOS FUEGIENSIS (Dana). (Pl. IX.)

1853-55. *Gammarus fuegiensis* Dana, U.S. Expl. Exp. vol. xiii. p. 954, pl. 65. fig. 8 a-h.

1862. *Mæra fuegiensis* and *M. fuegeensis* Bate, Catal. Amph. Brit. Mus. p. 194, pl. 35. fig. 4.

1906. *Lembos fuegiensis* Stebbing, Das Tierreich, vol. xxi. p. 600.

1909. *Lembos kergueleni* Walker, Tr. Linn. Soc. London, vol. xii. p. 337, pl. 43. fig. 6.

1909. (?) *L. kergueleni* Chilton, Subantarctic Is. of N. Zealand, p. 646, text-figs. 12 a, b.

In 1906 this species remained obscure, Dana having described and figured it only in the female sex. While naming it *fuegiensis* as if it belonged to Tierra del Fuego, he assigned it to the "Feejee" Islands. Now that Mr. Vallentin has obtained a male and a female specimen together from the Falkland Islands, I feel pretty sure that the "Feejee" Islands was not the original locality, but assigned through some lapse of memory as the rendering of *fuegiensis*, yet the distribution must be extensive, since Walker records the species from the Indian Ocean.

The male differs from *Lembos kergueleni* (Stebbing), taken from a considerable depth at Kerguelen Island, by the hand of the first gnathopod, which has a differently sculptured palm, and also by the second joint of the second gnathopod, which is here not a broadly expanded oval as in the other species. The expansion, however, is also absent from the specimen which Chilton, in 1909, identified with *L. kergueleni*, but that identification seems to me very doubtful, since the male here figured is apparently adult, to judge by the antennæ and gnathopods, and the size slightly larger than that of the accompanying ovigerous female. It scarcely needs observing that the expansion of the second joint of the second gnathopod, though it occurs also in *Eurystheus exsertipes*, is a very unusual feature. In the present species the second joint is not expanded either in the gnathopods or in any of the peræopods.

The eyes are small and round. The first antennæ have a long peduncle and longer flagellum, first joint of peduncle rather

shorter than the second, which is four times as long as the third; flagellum of 30 joints in the male, 26 in the female, accessory of 6 and 5 joints respectively. Second antennæ with long peduncle, last joint a little longer than the penultimate, a little shorter than the 13-jointed flagellum.

The mouth-organs and peræopods do not seem to offer characters of value specifically. The first gnathopods of the male are in near agreement with the figure and description given by Mr. A. O. Walker in 1909. My figure was drawn before I had realized the necessity of comparing it with Mr. Walker's. His description is, "hand three times as long as wrist, hind margin longer than palm, which is defined by a blunt, everted tooth, setose on the side; behind this is a large sinus followed by a prominent flat-topped tooth; dactylus swollen near the middle." In my specimen the front margin is rather longer than that in Mr. Walker's drawing and the blunt tooth is not everted, but such differences may well be individual. In regard to the first gnathopods of the female, with their slightly excavated palm, Mr. Walker's figure agrees fairly well with Dana's and with mine, which also was drawn before comparison with Dana's species had occurred to me as desirable. Mr. Walker speaks of the fourth and fifth peræopods as having "the 2nd joints wider than in the 'Challenger' specimen" (of *L. kergueleni*). That would not agree with the form here in question or with Dana's figure.

In the uropods Dana notices the long spines apical to the peduncles of the first and second pairs. In the first pair the rami differ slightly from Dana's figure in being a little longer instead of a little shorter than the peduncle, but on Dana's plate they are drawn *in situ*, which is unfavourable to minute accuracy of measurement.

The telson is considerably longer than broad, a fact that would scarcely be suspected from a lateral view. Length of male in much curved position 7 mm., at full stretch probably 10 mm. or more; female (with numerous eggs) nearly as long.

Locality. Falklands, from roots of *Macrocystis* at 2-4 fathoms, Jan. 14, 1902.

Fam. PHOTIDÆ.

1872-76. *Photidæ* Boeck, Skand. Arkt. Amphip. vol. i. p. 74, vol. ii. p. 546.

1906. „ Stebbing, Das Tierreich, vol. xxi. p. 602.

Gen. HAPLOCHEIRA Haswell.

1879. *Haplocheira* Haswell, P. Linn. Soc. N.S. Wales, vol. iv. p. 273.

HAPLOCHEIRA BARBIMANUS (G. M. Thomson).

1879. *Gammarus barbimanus* Thomson, Tr. N. Zealand Inst. vol. xi. p. 241, pl. 10 d. fig. 1.

- Mr. Vallentin obtained a specimen at Stanley in seaweed at low water of a spring tide, and others from a sponge on a schooner.

1899. *Ampithoidæ* Stebbing, Ann. Nat. Hist. ser. 7, vol. iv. p. 211.

1813-14. *Ampithöe* Leach, Edinb. Encycl. vol. vii. pp. 403, 432.
1906. *Ampithoe* Stebbing, Das Tierreich, vol. xxi. p. 631.

1852. *Amphithoe brevipes* Dana, P. Amer. Acad. vol. ii. p. 216.
 1853-5. " Dana, U.S. Expl. Exp. vol. xiii. p. 941,
 pl. 64. figs. 5 *a-i*, *k-n*, and *l, md, m*¹⁻³.
 1906. *Ampithoe brevipes* Stebbing, Das Tierreich, vol. xxi. p. 637.

A female specimen 20 mm. in length, carrying numerous small eggs, agrees remarkably well with Dana's figures and description, except that neither the first nor the second uropods have the rami so equal in length as his figure represents, nor is the more slender (and longer) ramus so devoid of spines. The glandular second joint in the first and second pereopods, so important for nest-building, is, as Dana notes, conspicuously swollen.

Locality. Found "with their 'nests' made on a frond of *Macrocystis pyrifera*, 1 foot from the surface," Nov. 24, 1898.

1906. *Jussidae* Stebbing, Das Tierreich, vol. xxi. pp. 8, 647, 739.

1814. *Jassa* Leach, Edinb. Encycl. vol. vii. p. 433.
 1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 652, 739.
 1913. „ Chevreux, Deuxième Exp. Antarct. française,
 Amphip. p. 181.

1808. *Cancer (Gammarus) falcatus* Montagu, Trans. Linn. Soc.
London, vol. ix. p. 100, pl. 5. fig. 2.
1906. *Jassa falcata* Stebbing, Das Tierreich, vol. xxi. p. 656.
1911. „ „ Sexton, J. Mar. Biol. Assoc. vol. ix. p. 212.
1912. „ „ Chilton, Tr. R. Soc. Edinb. vol. xlviii. p. 511.

Under Montagu's specific name Dr. Chilton groups a great
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variety of synonyms, including Pfeffer's *Podocerus ingens*, which attains a length of 26 mm., Walker's *Hemijassa goniamera* and *Jassa wandeli* Chevreux. In 1913 Chevreux points out that, though the adult male of his species proves to have second gnathopods very similar to those of *J. fulcatus*, it is nevertheless distinguished among other things by a more elongate carpus of the first gnathopods, the comparatively narrow second joint of the fourth and fifth pereopods in which the hind margin is almost straight, and by the less acute apex of the telson. In all these respects it is distinct from the little specimen here recorded, which has a length of only 3 mm.; the antennæ are well furnished with long setæ, and the second joint in the third, fourth, and fifth pereopods has a very decidedly convex margin.

Locality. Stanley Harbour, among seaweed at low water of spring tide.

Another specimen in the collection, which I should be inclined to identify with *Jassa ingens* (Pfeffer), measures 8.5 mm. in length. It has the second joint of the very elongate second gnathopod much curved, and the tooth of the large sixth joint irregular in shape, as described and figured by Pfeffer.

Fam. COROPHIIDÆ.

1888. *Corophiidae* Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 1154.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 8, 662, 739.

Gen. COROPHIUM Latreille.

1806. *Corophium* Latreille, Gen. Crust. Ins. vol. i. p. 58.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 663, 685, 739.

1908. „ Chevreux, Bull. Soc. Zool. France, vol. xxxiii. p. 69.

COROPHIUM CYLINDRICUS (Say).

1818. *Podocerus cylindricus* Say, J. Ac. Philad. vol. i. p. 387.

1873. *Corophium cylindricum* Smith & Verrill, Rep. U.S. Fish Comm. vol. i. p. 370.

1905. „ „ Holmes, Bull. U.S. Bureau Fish. vol. xxiv. p. 521, text-figs.

1905. „ „ Paulmier, Bull. New York Mus., Bull. 91, Zool. 12, p. 167, fig. 37.

1906. „ „ Stebbing, Das Tierreich, vol. xxi. pp. 692, 740.

The figures and description of the female supplied by Dr. S. J. Holmes leave no doubt that Mr. Vallentin's specimens belong to this species. Holmes gives the length as 3-4 mm. Paulmier gives it as 5 mm., probably with reference to a male specimen which he figures in full. The Falkland Island specimens, collected during low water of spring tides, measure only 3 mm. It is

possible that Dana's young *Corophium* (?) *quadriceps*, 2 mm. long, from Rio Janeiro, may be a synonym, and probable that *C. contractum* Stimpson, 1855, from Japan, later identified by G. M. Thomson in New Zealand waters, may likewise be another name for Say's widely distributed species.

Fam. PODOCERIDÆ.

1906. *Podoceridæ* Stebbing, Das Tierreich, vol. xxi. pp. 8, 694, 741.

1910. „ Stebbing, Mem. Austral. Mus. vol. iv. pp. 622, 650.

Gen. PODOCERUS Leach.

1814. *Podocerus*, Leach, Edinb. Encycl. vol. vii. p. 433.

1906. „ Stebbing, Das Tierreich, vol. xxi. pp. 700, 741.

PODOCERUS BRASILIENSIS (Dana).

1853 & 1855. *Platophium brasiliense* Dana, U.S. Expl. Exp. vol. xiii. p. 838, pl. 55. figs. 9 a-l.

1906. *Podocerus brasiliensis* Stebbing, Das Tierreich, vol. xxi. p. 704.

In this species Dana's figure shows the fifth joint of the second gnathopod in the male as quite distinct from the long joint which follows. In the example from the Falklands, as in one from the West Indies, this fifth joint is scarcely visible, in this respect agreeing with *Podocerus mangarevæ* Chevreux, 1907, of which the author says that the wrist is not clearly distinct from the hand.

It is possible that the species is not a true member of the fauna of the Falkland Islands, since Mr. Vallentin records his specimens as obtained from mud on a hulk sunk in Stanley Harbour.

Tribe CYAMIDEA.

1852. *Caprellidea* Dana, Amer. Journ. Sci. ser. 2, vol. xiv. p. 307.

1906. „ Stebbing, Das Tierreich, vol. xxi. p. 4.

1910. *Cyamidea* Stebbing, Ann. S. Afr. Mus. vol. vi. p. 464.

Fam. CAPRELLIDÆ.

1847. *Caprellidæ* White, List of Crust. Brit. Mus. p. 91.

1910. „ Stebbing, Ann. S. Afr. Mus. vol. vi. p. 464
(with synonymy).

Gen. CAPRELLA Lamarck.

1801. *Caprella* Lamarck, Syst. Anim. sans Vertèbres, p. 165.

CAPRELLA PENANTIS Leach.

1813. *Caprella penantis* Leach, Edinb. Encycl. vol. vii. p. 404.

1816. *C. acutifrons* Latreille, Nouveau Dict. d'Hist. Nat. vol. v. p. 433.

1843. *C. dilatata* Krøyer, Naturh. Tidsskr. vol. iv. p. 585, pl. 8. figs. 1-9.

1871. *C. dilatata* Cunningham, Tr. Linn. Soc. London, vol. xxvii. p. 478.

1890. *C. acutifrons* Mayer, F. & Fl. Neapel, vol. xvii. pp. 50, 51.

1910. *C. penantis* Stebbing, Ann. S. Afr. Mus. vol. vi. p. 465.

Mr. Vallentin obtained this species from *Macrocystis* after a gale on the 16th of Jan., 1910, and on other occasions from hydroids and fronds of *Macrocystis* at the mouth of Roy Cove.

Tribe PHRONIMIDEA.

1890. *Hyperiidea* Sars, Crustacea of Norway, vol. i. p. 5.

1906. „ Stebbing, Das Tierreich, vol. xxi. p. 4.

1910. *Phronimidea* Stebbing, Ann. S. Afr. Mus. vol. vi. p. 473.

Fam. HYPERIIDÆ.

1889. *Hyperiidæ* Bovallius, K. Svenska Vet.-Ak. Handl. vol. xx. no. 7, p. 74.

Gen. HYPERIA Latreille.

1823. *Hyperia* Latreille, in Desmarest, Dict. Sci. Nat. vol. xxviii. p. 347.

HYPERIA GAUDICHAUDII Milne-Edwards.

1840. *Hyperia gaudichaudii* Milne-Edwards, Hist. Nat. Crustacés, vol. iii. p. 77.

1888. „ „ Stebbing, Rep. Voy. 'Challenger,' vol. xxix. p. 1394, pl. 169.

1903. *H. gaudichaudi* Walker, J. Linn. Soc. London, vol. xxix. p. 40.

1907. „ „ Walker, Nat. Antaret. Exp. vol. iii., Amphip. p. 7.

The specimens were "removed from large Beroe," March 11, 1910.

LEPTOSTRACA.

1888. *Leptostraka* Claus, Arbeit. Zool. Inst. Wien, vol. viii, pt. 1, p. 5.

Claus here supplies a full discussion of his own and other views on the systematic position of this subclass, insisting strongly on the points of agreement with the Malacostraca.

Fam. NEBALIIDÆ.

1850. *Nebaliadæ* Baird, Brit. Entomostraca, Ray Soc., p. 31.

1896. *Nebaliidæ* Sars, Fauna Norvegiæ, vol. i. p. 6.

1900. „ „ Stebbing, Willey's Zool. Results, Part 5, p. 659.

1904. 'Die Leptostraken' Thiele, Ergeb. der deutschen Tiefsee-Exp. vol. viii.

1905. „ „ Thiele, Deutsche Südpol. Exp. vol. ix., Zool. i. p. 61.

In the interests of carcinological phylogeny attention may

here be called to Mr. C. D. Walcott's remarkable account of Middle Cambrian Crustacea (Smithson. Misc. Coll. vol. lvii. no. 6, 1912), in which he rather confusingly refers to the present group as Phyllocarida, Nebaliacea, and Leptostraca, without clearly indicating that he uses them as synonyms.

Gen. NEBALIA Leach.

1814. *Nebalia* Leach, Zool. Miscellany, vol. i. p. 99.
 1888. „ Claus, Arbeit. Zool. Inst. Wien, vol. viii. pt. 1,
 p. 122.
 1909. „ Chilton, Subantarctic Is. of N. Zealand, p. 669.

Other references coincide with those given above. It may be noticed that Leach assigned his genus to the subclass Malacostraca.

NEBALIA BIPES (O. Fabricius).

1780. *Cancer bipes* O. Fabricius, Fauna Groenlandica, no. 223.
 1888. *Nebalia bipes*, var. *chilensis* Claus, Arbeit. Zool. Inst. Wien,
 vol. viii. pt. 1, pp. 127, 132.
 1904. *N. b. chilensis* Thiele, Ergeb. der deutschen Tiefsee-Exp.
 vol. viii. p. 13, pl. 4. f. 73.
 1905. *N. bipes* Thiele, Deutsch. Südpol. Exp. vol. ix., Zool. i.
 p. 67.

A dissected specimen, apparently a young male, shows a rostrum with the proportions of length to breadth, 16:6, or slightly less than 6. The eyes have a little lateral projection. The first antennæ agree with those which Dr. Thiele describes and figures for his *Nebalia longicornis magellanica*. He allows that, on the whole, the southern *N. longicornis* Thomson differs little from the northern *N. bipes*. It seems to me very doubtful whether the specific distinction can be maintained. In one of Mr. Vallentin's specimens the second antennæ nearly reach the end of the caudal rami.

Locality. Whales Bay, May 17, 1910.

THYROSTRACA.

1893. *Thyrostraca* Stebbing, History of Crustacea, Internat. Sci.
 Ser. vol. lxxiv. pp. 6, 11, 31.
 1902. „ Stebbing, Encycl. Brit. ed. 10, suppl. vol. xxxiii.
 (9) p. 319.

Fam. LEPADIDÆ.

1851. *Lepadidæ* Darwin, Monogr. Cirrip., Ray Soc., vol. i. 1851.

Gen. LEPAS Linn.

1758. *Lepas* Linn., Syst. Nat. ed. 10, p. 667.

LEPAS AUSTRALIS Darwin.

1851. *Lepas australis* Darwin, Monogr. Cirrip., Ray Soc., vol. i. p. 89, pl. 1. fig. 5.

This species was taken in King George's Sound, on the shore after a gale, Sept. 15, 1910.

Fam. BALANIDÆ.

1854. *Balanide* Darwin, Monogr. Cirrip., Ray Soc., vol. ii. p. 33.

Gen. ELMINIUS Leach.

1825. *Elminius* Leach, Zoological Journal, vol. ii.

ELMINIUS KINGII Gray.

1831. *Elminius kingii* Gray, Zoological Miscellany, p. 13.

1854. " " Darwin, Monogr. Cirrip., Ray Soc., vol. ii. p. 348, pl. 11. figs. 6 a-6 e.

1911. *E. kingi* Ortmann, Princeton Univ. Exp. Patagonia, p. 637.

Points by which I have verified this species are the scutum without an adductor ridge, the labrum deeply notched, with five little teeth on each side, the mandible with four or five teeth. Darwin speaks of the first pair of cirri as having "one ramus nearly twice as long as the other." In the specimens dissected, the difference was not so considerable. The penis was stout except near the apex in one specimen, the thin part considerably prolonged in the other.

Mr. Vallentin's specimens were taken at low water of a spring tide affixed to *Mytilus edulis* in Stanley Harbour. He speaks of them as scarce.

EXPLANATION OF THE PLATES.

PLATE I.

Tanais ohlini Stebbing.

n.s. Line indicating natural size of female specimen figured below.

C. Dorsal view of head and first peræon segment, with first antennæ and first gnathopods; frontal line of head conjectural.

Pl., urp. Dorsal view of pleon, with left uropod.

oc., a.s., a.i. Eye, first and second antennæ.

m., mx. 1, mxp. Mandible, first maxilla, maxillipeds.

gn. 1, gn. 2, prp. 1, prp. 5. First and second gnathopods, first and fifth peræopods.

urp. Right uropod.

All the separate parts are magnified to a uniform scale, except the terminal joint of the fifth peræopod, which is further given in higher magnification.

PLATE II.

Exosphaeroma calcareus (Dana).

n.s. Lines indicating natural size of male specimen figured below in dorsal aspect.

C.V. Ventral view of cephalon with side-plates of first peræon segment, to give an idea of the epistome and first and second antennæ in position.

plp. 1. The first pleopod, along with the male organs on the last peræon segment.

plp. 2, 3, 4, 5. Second, third, fourth, and fifth pleopods, with apical parts of fourth and fifth more highly magnified.

PLATE III.

Tryphosites chevreuxi Stebbing.

n.s. Line indicating natural size of male specimen figured below.

a.s., a.i. First antenna and part of the second.

gn. 1, gn. 2. First gnathopod with distal portion more highly magnified, and second gnathopod.

prp. 2, 3, 5. Second and third peræopods, the latter without the branchial vesicle; fifth peræopod, with second joint only partially figured for economy of space.

urp. 2, urp. 3, T. Second and third uropods; telson in dorsal view, with higher magnification of the apex of the left division.

The separate parts are enlarged to a uniform scale, with additional enlargements of the first gnathopod and the telson.

PLATE IV.

Pariphimedia normani (Cunningham).

n.s. Line indicating natural size of female specimen figured below.

C. Partial side view of head.

l.s., l.s'. Upper and lower lips.

m., mx. 1, mx. 2. Mandible, first and second maxillæ.

gn. 1, gn. 2. First and second gnathopods.

All the separate parts, except the head, are magnified to a uniform scale. The marsupial plate of the second gnathopod is omitted.

PLATE V.

Pariphimedia normani (Cunningham).

mxp. Maxillipeds.

prp. 2, 3, 5. Second and third peræopods incomplete, and fifth peræopod.

urp. 1. First uropod, the peduncle incomplete.

urp. 2, urp. 3, T. Dorsal view of second and third uropods, with the telson.

For economy of space the peræopods are given on a lower scale of magnification. The other parts are uniform with those of the preceding Plate.

PLATE VI.

Monoculopsis vallentini Stebbing.

n.s. Line indicating natural size of the specimen figured below. The figure is partly schematic, as prior to dissection details of the crowded overlapping limbs could neither be clearly seen nor satisfactorily represented.

a.3., a.i. First and second antennæ.

l.s., mx. 1, mx. 2. Upper lip, first and second maxillæ.

gn. 1, gn. 2. First and second gnathopods.

PLATE VII.

Monoculopsis vallentini Stebbing.

m., l.i. Mandible and lower lip.

prp. 2, 3, 4, 5. Second, third, fourth, and fifth peræopods. The branchial vesicle and marsupial plate of the second peræopod are omitted.

plp. A pleopod.

urp. 1, 2, 3, 3. The right first uropod, the left second uropod, the pair of third uropods, with the peduncle only of the left first and the right second. The telson appears as if it were attached to the fifth segment of the pleon, but is really attached high up on the sixth which it overlaps.

In this and the preceding Plate the mouth-organs are more highly magnified than the other parts, but each set is on a uniform scale.

PLATE VIII.

Bovallia regis Stebbing.

n.s. Line indicating natural size of specimen figured below in curved position, some of the limbs omitted to prevent confusion.

a.s. First antenna.

l.i., m., m. Lower lip, the two mandibles.

gn. 1, gn. 2, prp. 5. First and second gnathopods, and part of fifth peræopod.

urp. 1, urp. 2. First and second uropods.

T., urp. 3. Telson and third uropod.

The mouth-organs are more highly magnified than the other parts. The limbs, uropods and telson are on a uniform scale, but the limbs and mouth-organs are not from the specimen figured as a whole, though of one approximately of the same size.

PLATE IX.

Lembos fuegiensis (Dana).

n.s. ♂. Line indicating natural size of male specimen figured below in lateral view.

a.s., a.i. First and part of second antennæ.

l.i. ♀. Lower lip of female.

gn. 1, gn. 2, gn. 1 ♀, gn. 2 ♀. First and second gnathopods of the male and of the female.

urp. 1, urp. 2. First and second uropods.

urp. 3, T. Sixth pleon segment with telson and third uropods attached, in dorsal view.

All the parts are drawn to a uniform scale, and all are from the male specimen, except those with the sign ♀.

25. Further Contributions to the Anatomy of the Ophidia.
By JOSEPH C. THOMPSON, Surgeon, U.S. Navy*.

[Received October 22, 1913 : Read April 21, 1914.]

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METHODS EMPLOYED.

A routine procedure is needed for recording and correlating observations made on the anatomy of serpents. In comparative anatomical studies of mammals, the position of an organ is given in terms of its relation to other viscera. With animals of a compact build this is amply sufficient; with serpents on the other hand, owing to their attenuated bodies, it is not adequate to state that one organ lies posteriorly to another. This drawing out of the body is accompanied by much variation as to the relative lengths of different organs and their distances apart. For example, the tip of the liver may be situated the distance of a dozen vertebrae behind the apex of the heart, with a thick-walled right lung filling the space between them, or it may overlap the apex of the heart by several millimetres, and the lung be a mere air-sac dorsal to the liver. The length of certain organs varies to a degree unknown in any other Order. For example, the right lung may terminate a few millimetres posterior to the end of the liver, or extend nearly to the cloaca.

If the gastrostegæ level at which the various structures occur is recorded, one may obtain data satisfactory for comparing different species or for determining the range of variation in a series. Take for example the data relating to *Thamnophis ordinoides*: the apex of the heart is recorded as being at the 26th, the anterior tip of the liver at the 70th, and the posterior end at the 86th gastrostegæ. It may be seen at a glance that the liver is nine gastrostegæ posterior to the heart and that it is of a definite length, extending over thirty-five shields†. For comparing series it will be found of advantage to reduce the records to a percentage. In each case the number of gastrostegæ in the specimen is to be taken as the base.

Returning to *T. ordinoides*: the number of gastrostegæ in an example of that species is 157, and the position of the heart or liver in terms of its distance down the spinal column is as follows:—Heart apex 16·6 per cent.; liver tip 22·3 per cent.; liver end 44·6 per cent. Behind the posterior pair of geneials there are usually one or two pairs of small gular shields; these are followed by from one to three shields in the median line which increase

* Communicated by Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S.

† To avoid frequent repetition the term gastrostegæ will be abbreviated to "g."

in width in pyramidal fashion. The shield regarded as the first gastrostegite is the one that is nearly the standard width; it is frequently distinguished by having a colour similar to the rest of the ventrals and not white or cream like the throat.

LIST OF SPECIES EXAMINED.

- Xenopeltis unicolor*, p. 380.
Polyodontophis geminatus, p. 380.
Polyodontophis collaris, p. 381.
Thamnophis ordinoides, p. 381.
Tropidonotus vibakari, p. 384.
Tropidonotus sauteri, p. 385.
Pseudoxenodon sinensis, p. 385.
Zamenis constrictor, p. 386.
Zamenis rhodorhacis, p. 387.
Zamenis florulentus, p. 389.
Coluber oxycephalus, p. 389.
Philothamnus semivariegatus, p. 394.
Cerberus rhynchops, p. 394.
Leptodira hotambœia, p. 397.
Psammophis sibilans, p. 398.
Ophiophagus bungarus, p. 398.
Doliophis bivirgatus, p. 400.
Causus rhombeatus, p. 401.

XENOPELTIS UNICOLOR Reinwardt.

Specimen.—California Acad. Sci. No. 16750. Singapore.
 Adult female: total length 480, tail 58 mm.

The *vertebral artery* arises from the right aortic arch at the 45th g. and courses superficially to the 12th g. It gives off an intercostal branch to each vertebra, and these enter in the median line. The *right aorta* is nearly the same diameter as the left. It gives off eight intercostal branches; each arises as a single trunk which bifurcates midway to the parietes, and the forks enter on either side of the median line. The *dorsal aorta* begins at the 52nd g. The *intercostal branches* arise anteriorly as a single trunk which upon reaching the parietes bifurcates, one fork entering on each side. Before the gall-bladder these bifurcate nearer to their origin, and behind this organ they are symmetrically paired. The right kidney receives two *renal arteries*; the first enters the second lobe, and the second the sixth lobe. The left kidney receives one artery which enters at the second lobe.

POLYODONTOPHIS GEMINATUS Boie.

Specimen.—California Acad. Sci. No. 16751. Botanical Gardens, Singapore. Adult male.

The *trachea* enters the lung at the level of the 36th g.; it

terminates two gastrosteges further on, and is without an intrapulmonary prolongation. The *tracheal membrane* is bare to a trifle above the base of the heart, at which point it acquires a thin lining of shallow-celled respiratory tissue. The *right lung* is lined with air-cells to the level of the 55th g. There is a *free apex* reaching forward for the distance of two gastrosteges and in relation with the right side of the trachea. The *left lung* is entirely suppressed. The *heart apex* is at the 38th, and the tip of the *liver* at the 50th g.

There are 144 *gastrosteges*. The *scales* are in 17 rows anteriorly and the same posteriorly.

POLYODONTOPHIS COLLARIS Gray.

Specimen.—California Acad. Sci. No. 26783. Mo Kan Shan, Chekiang Prov., China. Adult male.

The *tracheal membrane* begins to be lined with respiratory tissue a little before the base of the heart. The *trachea* enters the lung at the level of the 38th g. The *right lung* is lined with respiratory tissue to the 60th g. There is a *free apex* 3 mm. long in relation with the right side of the trachea. The *left lung* is entirely suppressed. The *heart apex* is at the level of the 36th and the tip of the *liver* at the 54th g. This is an unusually long distance between these organs, as the average of a Colubrine serpent is about ten gastrosteges. The points of all the *teeth* on the maxillary, palatine, and pterygoid bones are brown. The *mandibular teeth* are not in the normal alignment; those in the anterior third of the series are abruptly faulted inwards, so that they are set in about .7 mm. from the line of the remaining teeth.

There are 172 *gastrosteges*. The *scales* are in 17 rows anteriorly and the same posteriorly.

THAMNOPHIS ORDINOIDES Baird & Girard*.

The *salient character* is the range of variations that occurs in the number of scale-rows. A series of over one hundred specimens has been studied, and the following eight formulæ recorded:—21-19-17, that is 21 rows forward, decreasing to 19, and further along to 17; 19-21-19-17, that is 19 rows forward, increasing to 21 at about the level of the heart and continuing to the end of the liver, then decreasing to 19, and further on to 17; 19-17; 19-17-15; 19-17-15-13 (13 is the lowest number of scale-rows on the body that has been recorded in *Thamnophis*); 17-19-17-15; 17-15; 15-17-15; these lower counts prevail in specimens from the State of Oregon.

* According to the classification of the North American Garter-snakes as set forth by A. G. Ruthven, Esq., in his memoir, "Variations and Genetic Relationships of the Garter-snakes," 1908, Bulletin 61, U.S. National Museum, this species includes *Tropidonotus leptocephalus* (B. & G.) and *T. vagrans* (B. & G.).

Specimen. — U.S. National Museum No. 504006. Sausalito Peninsula, California. Adult female.

The *tracheal membrane* begins at the glottis; anteriorly it lies along the dorsal and right quadrant of the tube, and further on, at about the 16th gastrostege, it gradually winds to the dorsal quadrant. Anteriorly it is narrow and the ends of the cartilaginous rings are in apposition; at the 6th g. it is 1 mm. wide and begins to be lined with alveolar tissue; where the trachea enters the lung the membrane is 3.5 mm. wide and its alveolar lining becomes confluent with the respiratory tissue of the lung. The air-cells on the membrane near the end are smaller than those lining the anterior portion of the lung. The *trachea* enters the lung at the 24th g. From without it appears to terminate in an obtuse angle a few millimetres posterior to the base of the rudimentary lung; from within it is seen to continue along the ventral surface of the lung as a narrow, straight, and shallow gutter of fibrous tissue which reaches nearly to the anangious portion. The *right lung* is lined with pulmonary tissue to about the 40th g.; from this point on the air-cells become larger, more irregular, and deeper; they may be said to terminate, and the anangious portion to begin, at about the 45th g. From this point the lung continues as an air-sac to the level of the 106th g.

There is a *free apex* extending forward 8 mm. in relation with the right side of the trachea; this apex opens into the lung by a restricted aperture, 2.5 mm. in diameter, which is just anterior to the opening in the rudimentary lung. The rudimentary *left lung* is 7 mm. long, lined with air-cells, and opens into the trachea at a point 4.5 mm. anterior to where the trachea terminates in the right lung.

The *vertebral artery* rises from the right aortic arch at the level of the 20th gastrostege and is superficial in its course to the 10th g. It gives off five intercostal branches: I.-20; II.-16; III.-15; IV.-14; V.-12; and one branch to the œsophagus at the 14th g. The *right aorta* gives off a single intercostal branch close to its junction with the left; this branch arises at the 29th g., courses upwards and forwards and enters at the 27th g. The *left aorta* is only a trifle larger than the right and is without branches. The *dorsal aorta* begins at the 29th g.

There are sixty *intercostals*, and all but Nos. LVIII. and LIX. enter in the mid-dorsal line. The gastrostege level at which they leave the aorta is as follows:—I.-31; II.-35; III.-41; IV.-44; V.-50; VI.-53; VII.-55; VIII.-57; IX.-60; X.-62; XI.-64; XII.-66; XIII.-68; XIV.-72; XV.-73; XVI.-75; XVII.-77; XVIII.-79; XIX.-82; XX.-84; XXI.-86; XXII.-88; XXIII.-90; XXIV.-92; XXV.-93; XXVI.-95; XXVII.-96; XXVIII.-99; XXIX.-101; XXX.-103; XXXI.-104; XXXII.-106; XXXIII.-108; XXXIV.-110; XXXV.-111; XXXVI.-112; XXXVII.-113; XXXVIII.-115; XXXIX.-116; XL.-117; XLI.-119; XLII.-121; XLIII.-122; XLIV.-

123; XLV.-126; XLVI.-128; XLVII.-129; XLVIII.-131; XLIX.-132; L.-136; LI.-137; LII.-138; LIII.-142; LIV.-143; LV.-145; LVI.-147; LVII.-149; LVIII.-152; LIX.-153; LX.-156.

The courses of the intercostals vary slightly in different parts of the body. All but the last, LX.-156, enter the parieties anterior to their points of origin. Anteriorly the difference is only a millimetre or so; at the posterior end of the liver it has increased to an average of three to four millimetres, equivalent to the length of one vertebra. In the region of the kidneys each artery runs forward the distance of about two vertebræ before entering the body-wall. These latter branches are crossed by the renal arteries; the blood in the intercostal arteries flowing forward and in the renal arteries flowing backward. This arrangement is what might be expected to result from a lengthening of the body in this region. As the kidneys move to the rear the arteries entering them would be drawn out to the rear. As the dorsal aorta is drawn to the rear there is a tendency for the intercostal branches to maintain their former points of entrance; to accomplish this necessitates that they course forward. A few are peculiar in the following details:—I.-31 is the longest, measuring 11 mm.; II.-35 bifurcates, sending branches to the lung and œsophagus; III.-41, XX.-86, and XXI.-95 bifurcate and send one fork to the lung; LVIII.-152 enters 2·7 mm. to the left of the median line, and forks just before reaching the parieties; LIX.-153 enters a similar distance to the right; LX.-156 is the only one that enters the parieties at the same level as its origin, all the others trending forward to a greater or lesser extent.

The *gastric artery* is at the level of the 81st g.; upon reaching the stomach it bifurcates into anterior and posterior branches, the latter a trifle larger. There are three *mesenteric arteries*: I.-119; II.-99; III.-108. There are ten *intestinal, rectal, and cloacal arteries*; I.-113 is 32 mm. long; II.-119; III.-129; IV.-132; V.-139; VI.-145; VII.-151; VIII.-152; IX.-153; X.-155; the majority of these are long straight vessels.

There are four *renal arteries* on the right and seven on the left side. The right kidney extends from the 116th to the 139th g., and its four arteries leave the aorta as follows:—I.-118; II.-126; III.-129; IV.-135. All of these enter the organ posterior to their origin. No. I. is the largest; at the kidney it divides into an anterior branch which forks to supply the kidney and the ovary, and a posterior branch to the kidney alone. The left kidney extends from the 125th to the 145th g., and is practically the same size as its mate. The seven arteries leave the aorta as follows:—I.-122; II.-127; III.-131; IV.-135; V.-139; VI.-141; VII.-143. No. I. is the largest and forks to supply the ovary. Nos. I. to VI. are quite oblique; Nos. V. to VII. enter the kidney almost directly.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	157	100 per cent.
Heart apex	26	16·8
Liver, tip	35	22·3
" end	70	44·6
Gall-bladder	86	54·8
Kidney, right, tip	116	73·8
" " end	139	88·6
" left, tip.....	125	79·6
" " end	145	92·3

The number of *scale-rows* on the body, the sequence in which they are added and suppressed, and the gastrostege level at which these changes occur may be thus presented:—

Neck.

21 rows, IV row ends, right 8th, left 7th gastrostege, leaving:

Body.

19 rows, V row added, right 26th, left 24th gastrostege, making:
 21 " V " ends, " 72nd, " 72nd " leaving:
 19 " IV " " " 87th, " 90th " "
 17 " which are continued to the vent.

An inspection of this table will show that on the body the scale-row count is raised from 19–21 rows at about the level of the base of the heart, and that this maximum number of rows continues to the posterior end of the liver, where the original count of 19 rows is resumed. A further tapering of the body is indicated by the reduction of the 19 rows to 17, and this occurs just posterior to the gall-bladder. The relation existing between the position of the viscera and the added and suppressed scale-rows has been studied in fifty specimens of this species. The example just recorded offers the normal condition for individuals inhabiting the Sausalito Peninsula.

TROPIDONOTUS VIBAKARI Boie.

The *salient character* of this species is the peculiar type of intromittent organ. This has warranted the removal of the species from *Tropidonotus* and the establishment of a new genus *Hebius**.

Specimen.—California Acad. Sci. No. 15861. Yokohama, Japan. Adult female: total length 644, tail 140 mm.

The *trachea* ceases abruptly at a point just posterior to the apex of the heart. The *tracheal membrane* begins at the glottis and extends along the right side of the tube; from the origin to the 15th g. it is finely plicate; it then becomes lined with respiratory tissue, the alveoli being at first very shallow and indistinct; at the level of the auriculo-ventricular septum the

* Thompson, P. Z. S. 1913, p. 424.

shallow cells change rather suddenly to the type of those in the lung. The *trachea* ceases abruptly at a point just posterior to the heart apex. The *right lung* is lined with pulmonary tissue to about the 44th g. There is a *free apex* 1.5 mm. in length. There is a rudimentary *left lung*, a mere sac without air-cells or an opening into the trachea.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	147	100	per cent.
Heart apex.....	29	19.5	
Liver, tip	36	25.7	
" end	64	50.7	
Gall-bladder	76	55.7	
Kidney, right, tip	119	76.5	
" " end	128	87	
" left, tip	126	82.7	
" " end	137	93	
Ileo-cæcal valve	128	85.5	

There are 19 *scale-rows* anteriorly; at the level of the gall-bladder the IV row is dropped, leaving 17 rows which are continued to the vent.

TROPIDONOTUS SAUTERI Boulenger.

Specimen.—California Acad. Sci. No. 18988. Kanshirei, South Formosa. Adult female.

The *tracheal membrane* begins to be lined with respiratory tissue a little anterior to the base of the heart. The *trachea* enters the lung at the level of the 24th gastrosteg. The *right lung* is lined with respiratory tissue to the 55th g. There is a *free apex* about one and one-half gastrosteges long, in relation with the right side of the trachea. The rudimentary *left lung* is at the 25th g.: it is a mere fibrous sac, 2 mm. long, without pulmonary tissue. The *heart apex* is at the 24th, and the tip of the *liver* at the 32nd g.

There are 17 rows of *scales* anteriorly and the same posteriorly. *Gastrosteges* 128.

PSEUDOXENODON SINENSIS Boulenger.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-18. Yunnan Fu, China. Adult male.

The tissues in this specimen are in too fragile a state to permit of a satisfactory autopsy. The *tracheal membrane* is developed as a broad thin sheet; the air-cells begin at the 28th g. The cartilaginous rings are broader and thinner than in most species. There is a cervical set of *air-chambers* above and to the right of the trachea; these are divided into about seven compartments by transverse partitions. Each compartment opens into the trachea by a large round foramen situated on the tracheal membrane; these are opposite the following gastrosteges: 3, 7, 11, 15, 19,

23, 25. The *right lung* has a large free apex. There is no trace of the *left lung*.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	140	100	per cent.
Heart apex	30	21·4	
Liver, tip	40	28·6	
„ end	66	42·8	
Gall-bladder	75	53·6	
Kidney, right, tip	98	67·2	
„ „ end	120	85·7	
„ left, tip	111	79·2	
„ „ end	128	91·3	

The number of *scale-rows*, the sequence in which they are suppressed, and the gastrostege level at which they terminate are as follows:—

19 rows, IV row ends, right 68th, left 71st gastrostege, leaving:
 17 „ V „ „ „ 81st, „ 81st „ „
 15 „ which are continued to the vent.

ZAMENIS CONSTRICTOR Linnæus.

Specimen.—U.S. National Museum No. 504301. Sausalito Peninsula, California. Adult female.

The *tracheal membrane* begins at the glottis and extends along the left quadrant of the tube. It is bare anteriorly but becomes lined with respiratory tissue at the 15th g.; at first the air-cells are large and shallow, further on assuming the type of those in the lung. The *trachea* enters the lung at the 34th g.; a few millimetres posterior to the rudimentary lung it tapers to a narrow fibrous intrapulmonary band, less than 1 mm. wide, which continues along the ventral wall of the lung to the anangious part. The intercartilaginous fibrous portion of the trachea is pigmented a dark grey, which is in sharp contrast to the white of the cartilages and gives the trachea a regularly banded appearance. There is a *free apex* 5 mm. long, closely bound to the right side of the trachea, and with two small openings into the lung. The *right lung* is lined with alveoli to the 54th g., where they cease rather abruptly and the lung becomes anangious. The *left lung*, 2·5 mm. long, is at the 36th g.; it is lined with air-cells and opens into the trachea.

The *vertebral artery* courses superficially over seven gastrosteges; it arises from the right aortic arch at the 30th g. and enters in the median line at the 23rd g. It gives off two intercostal branches: I.-28, II.-26, and two minute twigs to the œsophagus: I.-27, II.-25. In another specimen (No. 504043, same locality and sex) having the same number of gastrosteges and with the heart at the same level, this artery courses over nine gastrosteges and gives off six intercostal branches: I.-28;

II.-27; III.-26; IV.-24; V.-22; VI.-21, and one to the œsophagus: I.-23.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	168	100 per cent.
Heart apex.....	35	20·9
Liver, tip	47	28
„ end	77	45·8
Gall-bladder	99	59
Kidney, right, tip.....	135	80·4
„ „ end.....	155	92·2
„ left, tip	142	84·5
„ „ end	160	95·2

The parietal *pleura* is pigmented along an irregular line on the flanks. The parietal *peritoneum* is darker and the pigment is more diffused until at the level of the pancreas it is quite black. The visceral peritoneum covering the liver is slightly darkened.

The number of *scale-rows* on the body, the sequence in which they become suppressed, and the gastrostege level at which they terminate may be presented thus:—

Neck.

19 rows, IV row ends, right 5th, left 136th gastrostege, leaving:

Body.

17 rows, IV row ends, right 94th, left 95th gastrostege, leaving:

15 „ which are continued to the vent.

ZAMENIS RHODORHACIS Jan.

The *salient characters* are:—The sequence of suppression of the scale-rows which is first No. IV, then IX, and finally VII;—over one hundred species of Colubrine snakes have been examined for this character, and this is the only one recorded with this formula. The caudad position of the heart. The attenuated liver. The of distance the gall-bladder from the liver,—fifteen gastrosteges, while it is usually ten in a Colubrine.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-7 a. Aden, Arabia. Adult male.

The *tracheal membrane* lies along the right side of the tube from the glottis to a little before the base of the heart where it becomes dorsal; it is narrow throughout and lies in a lax state, the interrupted ends of the cartilaginous semirings being in apposition; it is not attached to the extremities of the cartilages, but along a line about ·5 mm. distant. The air-cells begin at about the 55th g. The *trachea* ends abruptly at the 62nd g., there being no trace of an intrapulmonary bronchus. The *left lung* is completely suppressed. The *right lung* loses the lining of air-cells at the 77th g. There is an *apex* 3 mm. long, attached to the left side of the trachea and communicating with the lung by a restricted opening.

The *heart* is situated 27·6 per cent. down the vertebral column ; this is a little further to the rear than is usual in a Colubrine snake. The *liver* is much attenuated both anteriorly and posteriorly. The parietal *pleura* is very dark, the parietal *peritoneum* is almost black, and the visceral coverings are unpigmented.

The *vertebral artery* rises from the right aortic arch at the 54th g., courses superficially to the 44th g., and enters in the median line. There are four intercostal branches: I.-53; II.-52; III.-50; IV.-47. The *right aorta* has one large intercostal branch, I.-60, which enters to the left of the median line. The *dorsal aorta* begins at the 62nd g. The *intercostal arteries* enter the left side at the following gastrostegic levels: I.-70; II.-72; III.-75; IV.-77; V.-81; VI.-84; VII.-85; VIII.-87; IX.-89; X.-92; XI.-95; the branches beyond are injured.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	221	100 per cent.
Heart apex.....	61	27·6
Liver, tip	66	29·8
" end	109	49·5
Gall-bladder	134	60·4
Testis, right, tip	160	72·3
" " end	167	75·8
" left, tip	172	77·8
" " end	179	81·0
Kidney, right, tip	184	84·2
" remainder injured.		

The number of *scale-rows*, the sequence in which they are suppressed, and the gastrostegic level at which they terminate is as follows:—

Neck.

21 rows, IV row ends, right 7th, left 6th gastrostegic, leaving:

Body.

19 rows, IV row ends, right 129th, left 128th gastrostegic, leaving:

17 " IX " " " 129th, " 129th " "
 15 " VIII " " " 151st " "
 13 " which are continued to the vent.

The bodies of most serpents taper posteriorly and this is usually associated with the loss of definite scale-rows. The rows that are suppressed are prone to be either on the middle of the flanks or one or two rows distant from the median. When the rows on the flanks are dropped the levels at which they terminate are usually bilaterally asymmetrical, there being a difference of from one to four gastrosteges. When the rows adjoining the median are suppressed, the rule is for them to terminate at the same level. The pioneer work in this field has been done by A. G. Ruthven, Esq. Since the days of Cope, no American worker has given so astute a suggestion to students of herpetology as is contained in his memoir on the genus *Thamnophis*.

ZAMENIS FLORULENTUS Geoff.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-5. Blue Nile, Soudan. Adult male.

The *tracheal membrane* lies on the left side of the tube, and is narrow, being 1.5 mm. wide at the base of the heart. The air-cells begin at the 40th g. The *trachea* terminates at the 50th g. The remnant of the bronchus continues as a fine intrapulmonary streak of fibrous tissue as far as the anangious region. The *right lung* is without a free apex; the air-cells extend to the 66th g. A vestige of the *left lung* is present at the 50th g.; it is without air-cells or an opening into the trachea.

The *vertebral artery* leaves the right arch of the aorta at the 43rd g. and enters the parieties at the 35th. It has four intercostal branches which enter in the median line: I.-43; II.-41; III.-39; IV.-37. The *right aorta* extends from the 43rd to the 51st g. It has two intercostal branches: I.-45; II.-49.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	197	100	per cent.
Heart, apex	48	24.4	
Liver, tip	56	28.5	
„ end	96	48.7	
Gall-bladder	124	62.9	
Testis, right, tip.....	144	73	
„ „ end	148	75.2	
„ left, tip	158	80.2	
„ „ end	162	82.3	
Kidney, right, tip.....	166	84.2	
„ „ end.....	179	90.9	
„ left, tip	177	90	
„ „ end	189	96	

The number of *scale-rows*, the sequence in which they are suppressed, and the gastrostege level at which they terminate, are as follows:—

Neck.

23 rows, IV row ends, right 11th, left 10th gastrostege, leaving:

Body.

21 rows, IV row ends, right 120th, left 120th gastrostege, leaving:

19 „ VIII „ „ „ 122nd, „ 122nd „ „
 17 „ X „ „ „ 153rd, „ 153rd „ „
 15 „ which are continued to the vent.

COLUBER OXYCEPHALUS Boie.

The *salient characters* of this serpent are as follows:—The system of air-chambers opening into the trachea. The length of the right lung and the considerable development of the left; both lungs are larger than in any Colubrine as yet recorded. The intercostal branches of the vertebral artery do not all enter in the

median line. The highly differentiated intromittent organ. Finally the ugly and fierce disposition.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-17 *a*. Bala-kappan, Dutch Borneo. Adult male.

The *trachea* terminates abruptly at the 65th g. There is no trace of an intrapulmonary bronchus, the last vestige, the linear arrangement of the air-cells even being absent. The intercartilaginous membrane is black, and in sharp contrast to the white of the cartilages. Each end of a cartilage where the ring is interrupted by the membrane is free to the extent of .5 mm.; this gives a comb-like appearance to the line of junction of the cartilaginous and membranous portion. The *tracheal membrane* is not extensively developed, being uniformly about 2 to 3 mm., and at the base of the heart 4 mm. wide. Anteriorly it lies along the right and posteriorly along the dorsal side of the trachea. It is bare to the 49th g., where it acquires a lining of air-cells that posteriorly become continuous with those of the lung.

The body-cavity beneath the trachea from the level of the paired gular shields to the base of the heart is converted into an *air-chamber*. This structure gives the impression of crowding and filling all the available space. The walls are of stout connective tissue and are closely bound to the surrounding structures. The air-chamber is divided into fifteen separate compartments by connective tissue bulkheads that are imperforate. The position of the posterior wall of each compartment in terms of gastrosteges is as follows:—I.-3; II.-8; III.-13; IV.-18; V.-23; VI.-26; VII.-31; VIII.-36; IX.-39; X.-42; XI.-44; XII.-49; XIII.-52; XIV.-54; XV.-56. The after compartment is in relation laterally with the vena cava and the carotid artery and posteriorly with the base of the heart; it even sends a prolongation for a few millimetres along the ventral surface of the pericardium. Compartments XII. to XV. cease to be attached to the parietes and lie between the vessels of the neck and the trachea. Each compartment opens into the trachea by an *aperture*; in several cases there are two and even three openings. These apertures are situated on the tracheal membrane, close to the ventral row of cartilage-ends. They are oval, with the long axis in the sagittal plane, from 2 to 3.5 mm. in diameter, and extend over the space of several tracheal cartilages. Where they exist, the cartilages terminate flush with the rim of the opening, and do not have the free extremity that is present elsewhere. The first structure of this nature was discovered by Dr. Beddard* in *Ophiophagus*. In the Hamadryad it is dorsal to the trachea, whereas in *Gonyosoma* it is ventral.

The *right lung* extends posteriorly to the 230th g., which is just four shields anterior to the anal. It is one of the longest recorded in a Colubrine and resembles *Coluber corais* in this respect†.

* P. Z. S. London, 1903, vol. ii, p. 319.

† Beddard, P. Z. S. 1906, p. 520.

There is an *apex* about 18 mm. long, reaching to the 61st g.; it is above and to the right of the trachea, to which it is closely adherent posteriorly, the terminal 6 mm. only being free. The lumen of the apex communicates directly with the lung and is not set off by a restriction. The respiratory tissue ceases rather abruptly at about the 80th g.; its disappearance is not accompanied by the gradual change in size and shape of the air-cells so frequently seen.

The *left lung*, 86 mm. long, extends from the 62nd to the 80th g., and is the largest recorded in a Colubrine snake. The base is attached to the right side of the ventral surface of the right lung; it is 8 mm. long and corresponds to the 64th and 65th g. Though adherent to the right lung there is no direct communication between the two, the interpulmonary septum being imperforate. Just posterior to the base the diameter of the left lung is 7 mm. There is a free apex, 12 mm. long, extending forward nearly to the auriculo-ventricular septum; it is in relation with the left side of the pericardium, to which it is closely adherent. The posterior end of the lung extends 6 mm. beyond the anterior tip of the liver. The left lung is closely adherent to the inferior vena cava, and hides this vessel when the cœlum is opened from beneath. The left bronchus is merely a little bulge on the ventral side of the trachea 4 mm. anterior to its termination. There is no trace of a left intrapulmonary prolongation or fibrous band. The lung is lined throughout with regular air-cells; these are larger and more shallow than in the right lung.

The *pulmonary artery* courses along the right lateral edge of the right lung. Its principal branches are as follows: No. I, a minute one to the ventral surface of the apex. No. II, a large one which is at the level of the middle of the apex and winds around to its outer side and then turns to the dorsal surface of the lung. No. III enters the lung at the base of the apex. No. IV, very small, crosses to the right over the middle of the ventral surface of the isthmus joining the two lungs. No. V, a large branch, which runs along the posterior border of the isthmus and divides, sending several twigs to the right lung and a small branch to the left lung. The branches beyond are too irregular to describe in detail; some enter the lung direct, some wind around the right side to the dorsal surface, and one large one crosses the ventral surface and is distributed to the left side.

The *right aorta* gives the impression of being a branch of the vertebral artery*. It arises from the right side and is less than one half the calibre of that artery. It flows directly to the rear, forming an acute angle with the vertebral. It crosses to the left aorta and upon reaching that vessel at the 64th g. it courses alongside to the 68th g. before joining to form the dorsal aorta. There is a single intercostal branch which enters to the left of the median line at the 61st g.

* Quite as in *Zamenis flagelliformis*, Beddard, P. Z. S. 1904, vol. i. p. 338.

As it was not feasible to study the *vertebral artery* without injuring the air-chambers, this record was taken from another specimen (17 b, same locality), an adult female, with 243 gastrosteges and the heart apex at the 63rd g. The artery arises at the level of the 56th g. and courses superficially to the 23rd g., where it enters in the median line. There are fourteen intercostal arteries arising as follows: I.-56, this arises quite in the anterior angle formed by the vertebral and the right aorta and enters in the median line; II.-56, enters to the left; III.-52, bifurcates, and one fork enters on each side of the body; IV.-50, bifurcates, both forks enter in the median line; V.-47, this and the rest of the branches are single and enter in the median line; VI.-43; VII.-42; VIII.-40; IX.-39; X.-37; XI.-35; XII.-33; XIII.-30; XIV.-27.

In almost all serpents the intercostal branches of the vertebral artery enter the body-wall in the mid-dorsal line*. In this species the second and third branches offer two distinct types which are exceptions to this general rule.

The *right aorta*, .5 mm. in diameter, joins the left, 1.5 mm. in diameter, to form the *dorsal aorta* at the 68th g. The *intercostal* arteries anterior to the kidneys enter the parieties to the right or to the left of the median line: I.-73 and II.-83 to left; III.-87 to right, and at the entrance it sends a branch to the left side which bifurcates, sending one branch into the parieties and the other to the peritoneal muscle. In the lumbar region the intercostal arteries enter as follows:—At the 199th, 203rd, 204th, and 206th g. to the left. At the 208th g. a pair, one from each side of the aorta, and entering on either side of the vertebral column. At the 215th g. a single artery enters to the left. At the 215th and the 218th g. the vessels are paired. At the 226th g. the last artery is single and enters to the left.

The *right spermatic artery* arises at the 167th g. and enters just anterior to the middle of the gonad. The left arises at the 181st g. and enters the middle of the organ. Just posterior to each testis there is an artery arising from the aorta which enters the cord. There are five *renal arteries* on the right side. They arise as follows: I.-203, courses to the rear for about one gastrosteg, while the remainder enter nearly directly; II.-205; III.-208; IV.-215; V.-222. The left kidney receives six arteries as follows: I.-207; II.-209; III.-212; IV.-217; V.-219; VI.-222.

The *anterior vena cava* at the 40th g. is looped to form an S-shaped curve, parallel to the median plane, and with the recurrent limb measures 6 mm. This suggests the provision for the lengthening of the vein when the neck is inflated.

In the female (No. 17 b) the *gall-bladder* is 14 mm. in diameter, the *pancreas* 18 mm. long, and the distance between the two organs 6.5 mm.

The *hepatic duct* divides into about half a dozen tubes of un-

* Beddard, P. Z. S. 1904, vol. i. p. 368.

equal size. The *cystic duct*, 29 mm. long, arises from the anterior half of the ventral surface of the gall-bladder. Midway between the gall-bladder and the pancreas it divides into two branches. The smaller branch is one-third the diameter of the larger and divides into two branches near the anterior border of the pancreas. On the inferior surface of the pancreas the three branches of the cystic duct join the several branches of the hepatic duct to form a small but complex rete. Similarly complicated anastomoses have been recorded in the Python by Poelman and in the Hamadryad by Beddard.

The *external landmarks* of the principal viscera in terms of gaströstege are as follows :—

	Male.	Female.	Male. per cent.	Female. per cent.
Total number of gaströstege	234	243	100	100
Heart apex	65	63	28	26
Liver, anterior tip	81	75	35	31
" posterior end	115	108	45	44
Gall-bladder, centre	139	137	59	56
Pancreas, centre	142	139	61	57
Testis, right, anterior tip ...	168	...	72	...
" " posterior end...	173	...	74	...
" left, anterior tip	180	...	77	...
" " posterior end ...	185	...	79	...
Kidney, right, anterior tip...	202	208	86	85
" " posterior end.	225	233	96	96
" left, anterior tip ...	204	211	87	87
" " posterior end ...	233	233	99	96

It will be noted that in the female there are nine more gaströstege; in other words, the spinal column contains nine more vertebræ. In each specimen the posterior end of the liver and the anterior tip of the right kidney are very nearly at the same relative level. In each specimen the posterior end of the left kidney is exactly at the 233rd gaströstege. This indicates that the additional vertebræ in the female are situated between the end of the posterior kidney and the vent. The position of the vagina may require that the body be lengthened in this region.

* This serpent has received considerable attention from the early savants. It was discovered by Reinwardt in Java. By Wagler it was removed from the genus *Coluber* and made the type of the genus *Gonyosoma*; the determining character for this change was the lateral angles on the ventral shields; these are well shown in the plates given by Schlegel and Jan. Günther, in the 'Reptiles of British India,' writes: "It is described as exceedingly strong and fierce, defending itself ferociously when attacked. It raises nearly the anterior third vertically from the ground before it strikes." Cope, in the 'Crocodilians, Lizards, and Snakes of North America,' gives a figure of the hemipenis and places the genus apart from all the Colubrinæ, owing to the fact

that the intromittent organ is highly differentiated. To this may now be added the character to be found in the system of air-chambers opening into the trachea. These structural conditions will justify the removing of this serpent from the genus *Coluber* and reinstating the genus *Gonyosoma* of Wagler.

PHILOTHAMNUS SEMIVARIEGATUS Smith.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-6. Blue Nile, Soudan. Adult female.

The *trachea* is black and terminates at the 51st g. The *membrane* is well developed and lies along the right side of the tube: the air-cells begin at the 45th g. The *right bronchus* persists as an intrapulmonary streak to the 57th g. The *right lung* is lined with air-cells to the 68th g., where they end very abruptly. The *left lung* is a small air-sac opening into the trachea at the 51st g.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	204	100	per cent.
Heart apex.....	51	25	
Liver, tip	65	31·8	
" end	98	48	
Gall-bladder	114	55·8	
Kidney, right, tip.....	184	90	
" " end	198	97	
" left, tip	187	91·5	
" " end	200	98	

The *scale-rows*, the sequence in which they are suppressed, and the gastrostege level at which they terminate are as follows:—

Neck.

17 rows, IV row ends, right 4th, left 4th gastrostege, leaving:

Body.

15 rows, VI row ends, right 112th, left 110th gastrostege, leaving:

13 " IV " " " 114th, " 113th " "

11 " which are continued to the vent.

CERBERUS RHYNCHOPS Schneider.

The *salient characters* of this species are: All the teeth, without exception, are grooved. The tracheal membrane is lined with a peculiar type of deep air-cells. The shifting of the heart to the rear. The reduction of the renal arteries to one on one side and two on the other. The particularly tough connective tissue, which in this respect resembles that found in an Hydrophid and differs from the texture in a Colubrine.

Specimen.—California Acad. Sci. No. 15301. Cavite Viejo, Luzon, Philippine Islands. Cranium.

There are 16 *maxillary teeth* which are grooved on the external quadrant; separated from these by a small space are two slightly enlarged teeth, in a special compartment of mucous membrane,

and grooved on the anterior quadrant. There are 9 large *palatine teeth* which are grooved on the external quadrant. There are 21 *pterygoid teeth*, about one half the size of the palatine teeth and grooved on the internal quadrant. There are 23 *mandibular teeth* which are grooved on the external quadrant.

Specimen.—California Acad. Sci. No. 15309. Caloocan, Luzon, Philippine Islands. Adult male.

The *tracheal membrane* begins at the glottis and lies along the right side of the tube; at the 9th g. it is 1 mm. wide and at the 17th g. it is 2 mm. wide and begins to be lined with air-cells; at the 44th g. it has increased until it forms three-fourths of the circumference of the trachea; towards the base of the heart it decreases somewhat in size and merges with the lung. The *respiratory tissue* lining the tracheal membrane is of a specialized type, the individual air-cells being from three to four times deeper than wide. When the cartilaginous portion is laid open the lumen appears to be but 2 mm. in diameter; to the left may be seen the openings of the air-cells, which are in longitudinal rows. The cartilages lie at first on the right and beyond the 4th g. on the ventral side of the tube. The *trachea* ends abruptly at the 54th g., and there is not a trace of an intrapulmonary bronchus. The *right lung* terminates at the 94th g., which is the same level as the end of the liver. The posterior extremity is free and rounded as in the Boine type, and not bound to the parieties; upon opening the cœlum it may be seen just posterior to the end of the right lobe and to the right side of the left lobe of the liver. The lung is lined with air-cells throughout, but towards the end they become shallow and irregular. There is a free apex, 2 mm. long, on the right of the trachea, and extending to the 52nd g. The *left lung* is completely suppressed.

The *heart* is located rather to the rear, being in terms of gastrosteges 33 per cent. down the vertebral column, in Colubrine snakes the prevailing position is about 25 per cent. The *liver* is divided by an incisure along the ventral surface into right and left lobes; the right lobe begins at the 68th and ends at the 92nd g.

The *pulmonary artery* divides into two equal branches opposite the 51st g. The anterior is distributed to the trachea, the posterior to the lung. The branch to the lung divides just before the tip of the apex of the lung into dorsal and ventral branches.

The *vertebral artery* arises from the right aortic arch at the 48th g. and runs superficially to the 14th g.; just before disappearing it sends a minute twig forward to the next inter-vertebral space. It gives off 23 intercostal branches which enter in the median line; the gastrostege level at which they enter the parieties is as follows:—I. arises just at the origin of the vertebral and courses alongside of it to the level of the 45th g.; II.-43; III.-44; IV.-42; V.-41; VI.-39; VII.-38; VIII.-37; IX.-35; X.-34; XI.-33; XII.-30; XIII.-28; XIV.-27; XV.-26; XVI.-25; XVII.-24; XVIII.-22; XIX.-21;

XX.-20; XXI.-18; XXII.-16; XXIII.-14. The *right aorta* gives off two intercostal branches which enter in the median line: I.-47; II.-54. The *dorsal aorta* begins at the 58th g. and as nearly as can be determined gives off 44 *intercostal* branches which enter in the median line; the first is at the 57th g. and the last at the 148th g.

There are four *gastric arteries*, the largest being at the 87th and the 91st g. The *superior mesenteric artery* is at the 102nd and the *inferior mesenteric artery* is at the 112th g. Each testis receives a single *spermatic artery*; the right artery leaves the aorta at the 112th g. and enters the organ just below the middle; the left arises at the 119th g. and enters near the posterior end of the gonad. The right *renal artery* is single; it leaves the aorta at the 121st g. and enters near the anterior tip of the organ. The left kidney has two arteries: I. leaving the aorta at the 128th g. and entering near the tip; II. at the 137th g. and entering near the end of the organ.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	151	100	per cent.
Heart apex.....	53	35.1	
Liver, tip	62	42	
„ end	94	62.2	
Gall-bladder	102	67.5	
Testis, right, tip.....	111	73.7	
„ „ end.....	118	78.2	
„ left, tip	116	76.8	
„ „ end	123	81.5	
Kidney, right, tip	122	80.8	
„ „ end	135	89.4	
„ left, tip.....	129	86.5	
„ „ end	141	93.5	

The number of *scale-rows*, the sequence in which they become suppressed, and the gastrosteg at which this change occurs may be thus presented:—

Neck. There are from 28 to 25 rows, which to the level of the 15th g. are asymmetrical and too irregular to record.

Body.

23 rows, VI row ends, right 84th, left 98th gastrosteg, leaving:
 21 „ IV „ „ 106th, „ 105th „ „
 19 „ III „ „ 132nd, „ 131st „ „
 17 „ which are continued to the vent.

If this scale formula be compared with the one given under *Thamnophis ordinoides*, it will be seen that two fundamentally different types exist.

In the Colubrine snake the rows that were added or suppressed were in *adjoining series*.

In the Opisthoglyphine serpent they were *not in adjoining*

series, i. e. one, No. IX, was next to the median row, and the other, No. IV, was on the flank.

The scale formula of over one hundred species has been studied and the serpents possessing the non-adjointing type have usually been in the Dipsadomorphinæ. The following were the exceptions:—*Boodon lineatus* Dum. & Bibr., *Zamenis rhodorhacis*, Jan, *Z. florulentus* Geoff., and *Coluber oxycephalus* Boie.

This species is common in the vicinity of Manila, where it inhabits the brackish water swamps that border the Bay. Over a score have been seen in shallow places resting or moving slowly on the bottom. They are able to remain beneath the surface for several hours at a stretch. This may explain the need of the extensive respiratory area in the trachea and lung.

LEPTODIRA HOTAMBCEIA Laurenti.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-10. Fort Hall, British East Africa. Adult male: total length 950, tail 85 mm.

The *trachea* terminates at the 34th gastrostege; it ends abruptly, and the only trace of an intrapulmonary continuation is in a regular arrangement of the air-cells in an imaginary line in its prolongation. The *tracheal membrane* begins near the glottis on the left side; further on it winds to the dorsal side of the tube, and at the level of the 28th g. it becomes lined with shallow air-cells. The *right lung* is reticulate to the 47th g. The *left lung*, 2.3 mm. long, is at the level of the apex of the heart; it is closely adherent to the left side of the pericardium, and opens into the trachea at the 33rd g.

The *vertebral artery* arises from the right arch at the 29th gastrostege, and is superficial to the 18th; it gives off five branches, all of which enter in the median line. The gastrostege level of these branches is as follows:—I.-27; II.-26; III.-23; IV.-22; V.-20.

The *right aortic arch* joins the left at the 38th gastrostege; at the 31st it gives off a single intercostal branch, which bifurcates close to the entrance in the median line, one fork supplying each side. The *intercostals* from the anterior part of the dorsal aorta enter in the median line.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	163	100 per cent.
Heart apex.....	34	20.9
Liver, tip	41	25.2
„ end	81	49.7
Gall-bladder	90	55.3
Kidney, right, tip	129	80
„ „ end	155	95
„ left, tip	136	83.5
„ „ end	156	95.7

The number of *scale-rows* on the body, the sequence in which

they are increased or suppressed, and the gastrostege level at which these changes occur may be thus presented:—

17 rows, IX row added, right 15th, left 17th gastrostege, making:
 19 " IX " ends, " 102nd, " 104th " leaving:
 17 " IV " " " 105th, " 104th " "
 15 " which are continued to the vent.

PSAMMOPHIS SIBILANS Linnaeus.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-1. Nile Delta, Egypt. Adult male: total length 969, tail 315 mm.

The *tracheal membrane* is narrow, being only 1.5 mm. wide at the base of the heart; it is confined to the left side of the tube and the air-cells commence at the level of the auricles of the heart. The *bronchus* is continued as a fine intrapulmonary fibrous band to the level of the 55th g. The *right lung* is lined with pulmonary tissue to the 58th g. and is without a free apex. The *left lung*, 3 mm. long, opens into the trachea one gastrostege below the apex of the heart.

The *vertebral artery* arises from the right aortic arch at the 36th g.; it gives off six intercostal branches which enter in the median line—I.-33; II.-32; III.-29; IV.-28; V.-25; VI.-23; a branch to the œsophagus at 20 g.; at the 18th g. it bifurcates, sending a small intercostal branch into the parieties, and a larger one onto the dorsal surface of the œsophagus. The *right aorta* gives off an intercostal at the 36th g. The *common aorta* begins at the 43rd g.; the first few *intercostal* branches enter on the left side.

The *external landmarks* of the principal viscera in terms of gastrosteiges are as follows:—

Gastrosteiges	166	100 per cent.
Heart apex.....	41	24.7
Liver, tip	48	28.9
" end	82	49.4
Gall-bladder	100	60.3
Kidney, right, tip	142	85.7
" " end	163	98
" left, tip.....	146	88
" " end	164	98.8

There are 19 *scale-rows* on the neck. On the body there are 17 anteriorly, decreasing to 15 and finally to 13 rows posteriorly.

OPHIOPHAGUS BUNGARUS Schlegel.

The *salient characters* of the Hamadryad may be thus enumerated:—The large postparietal plates. The enlarged scales in the vertebral row. (This was first noted in a stuffed specimen in the Leyden Museum in which the skin had been stretched, until, each scale being free, the exact size and form was readily seen.) The extreme degree to which the grooving is developed on the teeth; every tooth except the fangs has one, and some have two and even three distinct grooves. The series

of air-chambers in the neck that open into the trachea. The size it attains and its aggressive disposition.

Specimen.—California Acad. Sci. No. 16777. Singapore. Cranium.

The *maxillary bone* extends beyond the palatine a distance of .8 mm. There are two fangs: the inner, 10 mm. long, are cemented in the erect position; the outer, of the same length, are loose and horizontal. There are three small teeth, 2.5 mm. long, situated on the posterior two-fifths of the bone; each has a groove along the antero-external quadrant that extends the entire length and is deeper and wider towards the base. The *ectopterygoid bone* is widened anteriorly and has a concave border forming an antero-external and an antero-internal process. The *palatine bone* has two processes. The maxillary process is short and directed inwards; its base extends from the middle of the third to the middle of the fifth socket. The vomerine process is narrow and is arched upwards, inwards, and towards the end slightly downwards; its base extends from the socket of the fifth to the sixth tooth. There are eight stout teeth, 2.8 mm. long, and each has three distinct grooves. The deepest groove is on the antero-internal quadrant and extends from the base to the tip. The next is not quite so deep; it is on the inner quadrant and extends from the base nearly to the tip. The last and least pronounced is on the external quadrant; it is deeper on the distal half of the tooth. The *pterygoid bone* is broadly expanded posteriorly and but slightly curved. The articulation with the ectopterygoid extends from the space between the fourth and fifth tooth to a point 2 mm. behind the last tooth. There are ten stout teeth, 1.5 mm. long, situated on the anterior two-fifths of the bone. Each tooth has two grooves; the deeper is on the internal quadrant and the other on the external quadrant. The *dentary bone* bears fourteen teeth, the anterior of which are a trifle the larger. All are deeply grooved along the exterior quadrant.

With the modification of the anterior maxillary teeth as fangs, and the small teeth on the maxillary and dentary bones being grooved, the King Cobra exhibits a further development of the poison apparatus, as the teeth on the palatine and even on the pterygoid bones are also grooved.

Measurements in millimetres.

Base, tip of præmaxillæ to rim of	
foramen magnum	46
Maxillary	13.9
Ectopterygoid	17.6
Palatine	17
Pterygoid	32.5
Mandible	61.2
Dentary	25.2
Quadrato	20.3
Squamosal	18.7
Fang ..	10

Specimen.—California Acad. Sci. No. 15340. Butuan, Mindanao, Philippine Islands. Head and neck of an adult.

A native was bitten by this beast at noon and died at seven in the evening. In conformity with the local folk-lore the serpent was decapitated, and the brain scooped out and applied to the wound as an antidote.

The anatomy of this form has been made the subject of a most interesting paper by Dr. F. E. Beddard*, who discovered the existence of the remarkable system of air-chambers connected with the trachea. This specimen contributes a couple of minor details to the description. The cartilaginous portion of the *trachea* is U-shaped, with the interrupted ends to the right. The *tracheal membrane* begins close to the glottis and runs along the right side as far as the 16th gastrostege; at this point it is tense, parallel to the sagittal plane, and 6.5 mm. wide. The transverse diameter of the trachea is also 6.5 mm. at this point. The air-chambers are to the right of the trachea. The first compartment is 55 mm. long and reaches from the level of the 2nd gastrostege to the 11th g.; it has one foramen, 1.7 mm. in diameter, at the 6th g., and another, 2.7 mm. in diameter; these are situated on the tracheal membrane and communicate with the lumen of the windpipe. The second compartment, 12 mm. long, extends from the 11th g. to the 13th g.; it has one foramen, 1.3 mm. in diameter, near the posterior wall. At the middle of this chamber there is an oval thin spot on the tracheal membrane. These thin spots have been observed and referred to by Dr. Beddard as "imperforate foramina." The third compartment, 9.5 mm. long, extends from the 13th to the 15th g.; near the anterior wall is a foramen 2.3 mm. in diameter, and near the posterior wall an imperforate foramen.

The only other serpents known to possess a similar system of air-chambers are *Pseudoxenodon chinensis* and *Coluber oxycephalus*. The latter has in addition one of the longest right lungs recorded in a Colubrine. To complete the data for the Hamadryad it is necessary to ascertain the distance the anangious portion of the right lung enters the cœlum. In the ordinary museum specimen this is not easy to determine. A useful procedure is to suspend the specimen and to inject into the trachea a little 95 per cent. alcohol, tinged with eosin, and allow it to trickle down into the lung. With the least bit of luck the fluid will reach quite to the end and stain the lung, so that it stands out in fair contrast. The main point in the technique is to employ an extremely weak staining solution.

DOLIOPHIS BIVIRGATUS Boie.

Specimen.—California Acad. Sci. No. 33059. Sarawak, Borneo. Adult male: total length 1319, tail 128 mm.

The *tracheal membrane* in this species is of large dimension.

* P. Z. S. 1903, vol. ii. p. 319.

It begins at the glottis and rapidly widens to comprise 50 per cent. of the circumference of the tube; at the 42nd gastrostegite it has increased in width to 66 per cent., and just before the heart it is fully 80 per cent. The cartilaginous rings are markedly thin and weak; towards the end of the trachea they lie along the dorsal and left segment of the tube. The *trachea* for its entire length is destitute of air-cells. It gives every indication of filling all the available space along its course. There is no line of demarcation to show where it ends and the lung begins. The alveolar tissue of the *left lung* is thin; it begins very gradually at about the level of the auriculo-ventricular septum, and continues to the 116th g.; from this point to the 128th g. there are a few large irregular air-cells before the anangious portion begins. There is no *free apex* and no rudimentary *left lung*. The *heart apex* is at the 91st g., and the tip of the *liver* at the 101st. *Gastrosteges* 272. There are 13 rows of *scales* from the neck to the level of the 265th g.; at this point the median row is suppressed, leaving 12 rows.

CAUSUS RHOMBEATUS Lichtenstein.

Specimen.—Brit. Mus. Nat. Hist. Ex. No. '13-11 a. Fort Hall, British East Africa. Adult male.

The *trachea* increases in diameter and occupies a large part of the cervical region; its walls are almost entirely formed by the membrane. The *tracheal membrane* begins on the left side at the level of the glottis; it rapidly widens, and after a few millimetres becomes lined with pulmonary tissue which in no respect differs from that found in a normal lung.

The *cartilaginous portion* at the origin almost surrounds the tube, being incomplete only on the left; at the 12th gastrostegite it becomes ventral and forms a small U-shaped gutter, 1.5 mm. in diameter; as it approaches the heart it gradually flattens out and is continued onto the anangious portion as a band. This *intrapulmonary bronchus* ends at the 65th g.; it is not a mere strip of fibrous tissue but a flat band of similar structure to the tracheal wall, with the alternate sections of cartilage and connecting membrane. The *right lung* has a very scanty lining of pulmonary tissue; thickly-set air-cells cease on the ventral surface of the tracheal membrane at the 32nd g., dorsally they are continued a little further; from this on to the heart apex there are large oblong cells extending along each side of the tracheal band; on the lateral walls of the lung these alter to an irregular shallow honeycomb structure; posterior to the heart apex the lung is a simple air-sac, with the remnant of the bronchus along its ventral wall. The *left lung* is completely suppressed.

The *heart* is situated principally to the right of the median line; it is rotated on its long axis until the right auricle is nearly dorsal to the left.

The *pulmonary artery* divides 3 mm. from its origin into

pulmonary and tracheal branches. The pulmonary branch is much the smaller; it runs along the left lung, at first to the left, then down the centre of the bronchial band. The tracheal branch runs anteriorly along the tracheal membrane.

The first portion of the descending limb of the *left aortic arch* lies to the right of the left ventricle; this would be equivalent to lying on the ventral surface of the heart were that organ not rotated. The left aorta crosses to the left side ventrad to the space between the heart apex and the liver tip; it then winds around the œsophagus at the 46th g. and continues closely adherent to and beneath the lung just to the left of the bronchial band. The few *intercostal* arteries noted enter in the mid-dorsal line. There is a single *spermatic artery* on each side. There are nine right and ten left *renal arteries*: these are short and enter directly. The *liver* is situated almost entirely to the right of the median line; like the heart it also is rotated on its long axis; the right lobe is dorsal to the left and posteriorly is 3·5 mm. longer. The *hepatic duct* joins the cystic duct at the 85th g. and the common duct enters the ventral surface of the pancreas. The parietal *peritoneum* is greyish-brown; the visceral coverings are but slightly tinged with the exception of that on the testis which is very dark.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:—

Gastrosteges	145	100 per cent.
Heart apex.....	42	29
Liver, tip	41	28·3
„ end	72	49·7
Gall-bladder	83	57·3
Testis, right, tip	95	65·6
„ „ end	100	69
„ left, tip	105	72·5
„ „ end	109	75·2
Kidney, right, tip.....	108	74·5
„ „ end	138	95·2
„ left, tip	116	80
„ „ end	139	95·9

The *scales* are in 19 rows anteriorly, decreasing to 17 and finally to 15 rows posteriorly. *Gastrosteges* 145.

26. The Coloration of the African Hunting Dog (*Lycaon pictus*). By Major J. STEVENSON-HAMILTON, C.M.Z.S.

[Received March 17, 1914; Read April 21, 1914.]

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Variation and Ætiology.

The classification into several subspecies of the Hunting Dogs of South Africa has been apparently based upon the supposed fact that animals inhabiting certain regions of the sub-continent display colour-patterns clearly distinguishing them from their relatives in other such regions, and so justify their division into different sub-races.

My own acquaintance with the Hunting Dogs of other parts of South Africa is purely cursory; but of those inhabiting the Transvaal, especially the north-eastern portions, I have a fairly intimate knowledge. I should remark here that, while, as I shall endeavour to show, some of the distinctions of pattern and colour brought forward as evidence of distinctive race are merely individual peculiarities, there seems no doubt that the animals native to the deserts of the south-west of the Union of South Africa tend to be very much lighter in general colour than those inhabiting the forests and savannas of the north and east.

I do not know to what type or types the Hunting Dogs of the Transvaal Province would be assigned, but the natural features dividing the western from the eastern portions of the Province are very much more formidable than those which separate, on the one hand, the eastern Transvaal from Rhodesia on the north and from Zululand on the south, and, on the other, the western Transvaal from Bechuanaland and Cape Colony respectively. Seeing, then, that the Hunting Dogs of Zululand, which certainly rub shoulders with the animals from the eastern Transvaal on the common ground of Swaziland, have acquired the dignity of a separate subspecies, it might reasonably be expected that the animals from the eastern and western Transvaal and bush countries, separated as they are from one another by several hundred miles of plateau country, which is civilized and practically devoid of all wild game for many years past, would be still more mutually distinct.

It is the case, however, that in the eastern Transvaal there are found, in the same locality and even within the same pack, colour-patterns which would fit, not only any of the determined subspecies, but, if produced singly for classification on the same grounds, no doubt seemingly would justify the establishment of a good many more.

Again, it would be quite impossible to distinguish a group of animals obtained, say, from Rustenburg in the west, from a similar group selected haphazard from Lydenburg in the east. Almost every individual shows certain special peculiarities, but the general type of animals in the two widely separated districts in no wise differs. In each we find the three colours of the coat variously predominating in different individuals: throat ruffs, backs of ears, black streaks on neck, show little uniformity. The markings of the tails vary in extreme cases from all white to all black, and while white tips are the rule, black ones are far from uncommon.

The eastern Transvaal borders on the Mozambique Province of Portuguese East Africa, from which it is separated only by the low ridges of the Lebombo Hills, crossed freely by all wild animals. It is known, in fact, that the various packs of Hunting Dogs which ravage the Transvaal Game Reserves on the eastern frontier, travel long distances into Mozambique, and no doubt breed largely within that territory. It might, therefore, be confidently anticipated that these animals would adhere closely in type to the described subspecies *Lycaon pictus typicus*.

In the large number of skins which I have seen at various times, some of which are still in my possession, it is, however, quite impossible to reconcile all the colour types and markings with one described subspecies. I am speaking now of the area of the eastern Transvaal extending from the Limpopo River in the north to the Crocodile River in the south, a range of not quite four degrees of latitude.

I would specially mention three skins obtained in 1913. Two of these represent a male and a female shot in November from the same pack, at a spot near the Portuguese border of the Transvaal, approximately 24° 46'S lat. I selected them from several others secured on the same occasion, as presenting the most divergent types. In one the yellow was considerably in excess of the black, and the tail was mostly white with a black patch in its basal half. In the other the two colours were reversed in quantity upon the body, and the whole of the distal half of the tail was black and the rest yellow. The latter skin, however, had less black upon the ears than the former. The others in the pack all displayed various colour-patterns of an intermediate nature, some with white patches in the coats.

The skin of the third specimen was that of a large male shot in about the same longitude as the others, but some thirty miles farther north, in August, 1913. It belonged to a different pack. Its coloration represented a third type, and between it and the two extremes one finds all sorts of variations. It was

the representative of a rather common intermediate type of colour-pattern, in which there is a fair amount of white shown on the body and limbs, and the tail is about half black and half white.

The northern part of the Sabi Reserve is covered with dense thorn bush, and in the neighbourhood of the large Olifants River is rather stony. Then comes a stretch of savanna country some 70 miles in width, after which, in the neighbourhood of the Sabi River, the country is the same as that first described. In both the first and last the game is of similar character, mainly Impala and smaller antelopes, with large numbers of Reedbuck in certain localities. In the savanna country are found mainly Waterbuck and the plain-dwelling antelopes. Thus the Hunting Dogs in these areas have to adapt themselves to slightly different conditions of hunting, and while there is no doubt that in the south and north they find that their prey comes comparatively easily, in the centre they have to work hard to secure it.

So far as my observations have gone it seems pretty certain that the savanna packs stick in the main to their own country, though they occasionally raid north and south into the bush. The same may be said inversely of the bush packs, north and south. One might, perhaps, recognise some general similarity of type between the bush packs of the north and south respectively, in which, on the whole, the individuals are larger than are those of the savanna country, and agree in being less extreme in colour-patterns of their coats. But these animals of the north and south probably never came into direct contact with one another, whereas the intermediate packs touch each of them. Instead, then, of having a gradual transition of type from north to south, we find that the extremes have certain affinities in common, mainly as regards size, and this may perhaps be accounted for by the relative amount of food available for the young animals. This is doubtless the foundation for the native belief that there are two species of Hunting Dogs within the same area, one larger than the other.

As regards colour-types, however, all agree in their individual dissimilarities.

The following are a few measurements, taken at various times, of full grown animals from the Portuguese boundary of the eastern Transvaal.

Sex.	Head and body.	Tail (excl. of end hairs).	Neck.	Fore leg.	Girth.	Height.
Male	43	13½	16	5	25	
"	41	14	...	...	...	27½
"	45	14½	...	...	26	28½
"	42	14	...	...	25½	
"	41	14	13	...	23	28
"	40	13				
"	43	14	16	6	26	
"	42½	14¼	16¼	5½	24½	
"	45	14	17½	6	27½	30*
"	41	14	...	...	25	
"	39	13¼	15	...	24	26½
Female ...	38½	13½	15½	5¼	24	
" ...	37	12	...	...	23	26½
" ...	39¼	14½				
" ...	36½	12	...	...	...	26

* The weight of this specimen, uncleaned and two hours after death, was 60 lbs.; it was in spare condition (Hunting Dogs are mostly fat in my experience).

Steel tape measurements in inches.

Heights measured from highest point of withers to back of palmar pad of fore foot.

Measurements round centre of fore leg midway between elbow
 " " body behind elbows. [and wrist.
 " " centre of neck.

27. On a New Cestode from an Albatross,
Diomedea irrorata. By H. A. BAYLIS, B.A.*

[Received April 21, 1914; Read May 19, 1914.]

(Text-figures 1-4.)

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Account of <i>Tetrabothrius strangulatus</i> , sp. n., in <i>Diomedea irrorata</i> from Peru.....	407

Among some material presented to the British Museum by the Hon. N. C. Rothschild, one tube contained specimens of a small cestode collected from *Diomedea irrorata* Salvin by Dr. H. O. Forbes. Locality : Lobos de Tierra Island, Peru.

Examination of these specimens showed them to belong to the genus *Tetrabothrius* Rudolphi, to which in fact all the Cestodes found in this group of birds have been assigned. The species appears to be a hitherto undescribed one, for which I propose the name *Tetrabothrius strangulatus*, on account of the sudden constriction observed behind the head, which gives the animal the appearance of having had a thread tied round its neck.

TETRABOTHRIUS STRANGULATUS, sp. n. (Text-figures 1-4.)

External Features.

This is a very small form compared with most of the other species of the genus. The material is unfortunately in a rather fragmentary condition; the longest piece measured 57 mm. This fragment contained 222 proglottides, in the first 5 or 6 of which there were as yet no traces of genital organs developed. The only fragment which includes a head shows about 30 segments, in which there are no genital organs, and the length of this piece is about 3.5 mm., including the head. At the lowest computation, therefore, a complete specimen probably measures 60 mm. in length and contains about 250 proglottides. The maximum width attained is about 0.77 mm.

As already stated, only one head could be found among the specimens. It is of a somewhat oblong shape, flattened dorso-ventrally—i. e., in the same direction as the strobila. At the apex it has a flattened area, from which arises a slight conical projection. The four suckers are large, placed at the anterior end of the scolex, and occupying less than half of its length. They have a considerable ear-shaped fleshy expansion antero-laterally, and their apertures are irregularly triangular in outline.

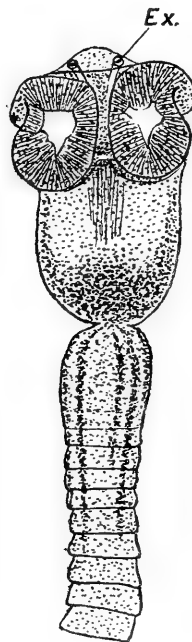
The total length of the head is 0.54 mm., while at its widest

* Communicated by the SECRETARY and published by permission of the Trustees of the British Museum.

part (through the lappets of the suckers) it has a transverse measurement of 0·36 mm. Its width behind the suckers is 0·28 mm. The suckers are 0·22 mm. long, and 0·15 mm. broad in the middle of their length.

There is no rostellum, and no hooks.

Text-figure 1.



Head of *Tetrabothrius strangulatus*, \times ca. 70.

Ex. Aperture of excretory canal (paired).

All figures were drawn with Abbé's drawing apparatus.

The apex of the head bears two pairs of curious apertures in front of the suckers. These have the form of small, clear, circular areas, crossed by a minute transverse slit. They are probably apertures of the excretory canals, fine branches of which can be seen passing up to the openings in the head. A similar structure has been noted by von Linstow in *Tetrabothrius heteroclitus* [*T. auriculatus* *]. Behind the head there is a sudden sharp constriction, forming an isthmus only 0·08 mm. in width. After this the width of the neck increases rapidly again to 0·17 mm.

Segmentation begins at about 0·25 mm. behind the constriction the earliest proglottides being about 0·05 mm. long by 0·14 mm.

* Voyage of H.M.S. Challenger, Report on Entozoa (1884), pp. 14-15.

wide. They increase rapidly in both dimensions on passing backwards, but are always broader than their length.

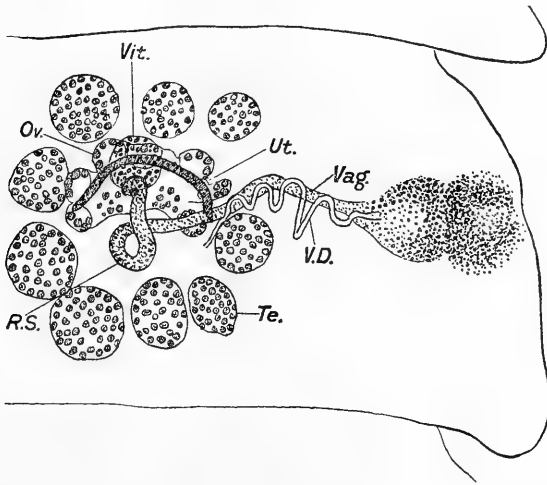
Internal Anatomy.

Musculature.—The longitudinal bundles of muscle-fibres are arranged in two layers, which are most strongly developed dorsally and ventrally. The outer layer consists of slightly smaller bundles than the inner layer, and is scantily developed towards the middle line of the segments, being more in evidence towards the sides. But neither layer is strongly developed quite up to the lateral margins.

The inner layer consists of about 25 to 30 bundles.

Transverse and dorso-ventral fibres are only feebly developed.

Text-figure 2.



Tetrabothrius strangulatus.

Semi-diagrammatic view of the anatomy of a young, sexually mature, segment, as seen from above by transparency.

Ov., Ovary; *R.S.*, the coil destined to become the receptaculum seminis; *Te.*, testes; *Ut.*, uterus; *Vag.*, vagina; *Vit.*, vitelline gland; *V.D.*, vas deferens.

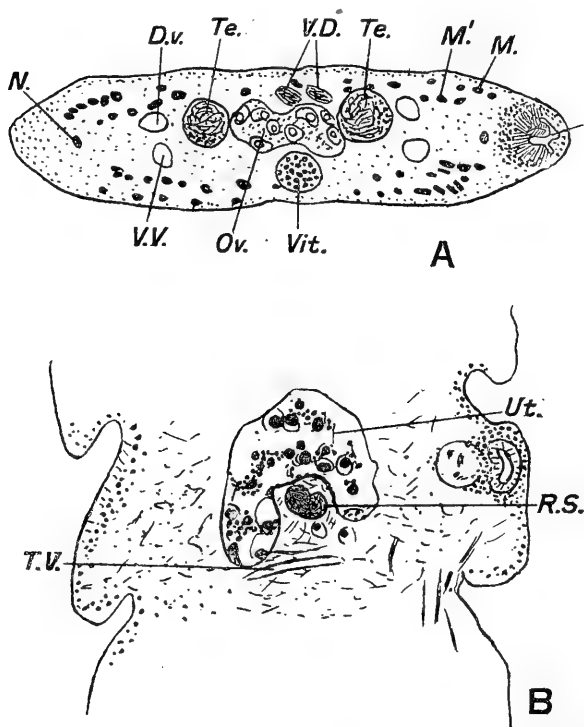
Nervous System.—The usual pair of longitudinal lateral nerves is present; they are situated slightly beyond the most lateral of the inner longitudinal muscles.

Excretory System.—As usual, two pairs of wide longitudinal lateral vessels are present. The dorsal pair is situated almost exactly vertically above the ventral pair, and are of nearly the same diameter. The ventral canals are connected in the posterior part of the segments by transverse vessels.

In the scolex fine canals can be seen running up to open by the peculiar slit-shaped apertures on the apical projection.

Genital Organs.—The testes are proportionately large, compared with those of other species of the genus, and are also remarkably few in number. They are nearly spherical, and have a diameter of about 0.055 mm. They are situated in the dorsal part of the central field of the proglottis, and arranged on a horseshoe plan round the other organs, which occupy the centre and more ventral parts. The two ends of the horseshoe are directed towards the right side of the animal, on which the genital pores are always situated, and the male and female genital ducts pass between them.

Text-figure 3.



Tetrabothrius strangulatus.

A. Transverse section through a sexually mature segment.

D.v., Dorsal excretory vessel; *G.A.*, genital atrium; *M.*, outer, *M'*, inner, longitudinal muscles; *N.*, lateral nerve; *Ov.*, ovary; *Te.*, testes; *V.D.*, vas deferens; *Vit.*, vitelline gland; *V.V.*, ventral excretory vessel.

B. Horizontal section through a gravid segment.

R.S. Receptaculum seminis; *T.V.*, transverse excretory vessel; *Ut.*, uterus.

The number of testes varies between 7 and 9, but the most usual number is 8.

The ovary is a somewhat loose and irregularly lobed organ in which the ova do not appear to be very closely packed. It occupies the greater part of the centre of the proglottides in the younger portion of the strobila.

Below the ovary, and extending a little in front of it, lies the large, rounded vitelline gland, while above the ovary, in young proglottides, the uterus appears as a very narrow crescentic tube with conspicuous cell-nuclei, the convexity of the crescent being towards the head of the worm.

In such a young segment, the genital ducts and apertures are difficult to separate, the common genital atrium being as yet imperfectly developed.

The vagina first appears as a rather wide canal running inwards from the thickening on the right side, which is to be the genital atrium; at first it runs a nearly straight course, with a slight forward inclination. It then turns backwards at an obtuse angle, and forms a remarkable loop, returning over itself and running upwards and forwards for a short distance, finally taking a sharp bend downwards and descending perpendicularly to the ovary. At the point where the backward loop of the vagina occurs, there is at first no perceptible enlargement of the duct, which appears to be of the same width throughout. But in older segments there is in this position an expansion to form a receptaculum seminis. In sections of the older proglottides this is always seen to occupy the space between the backwardly-directed "horns" of the uterus.

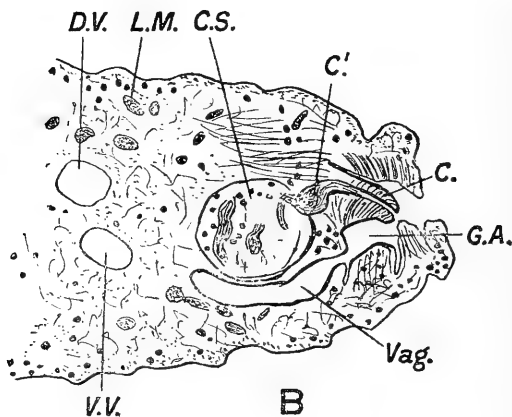
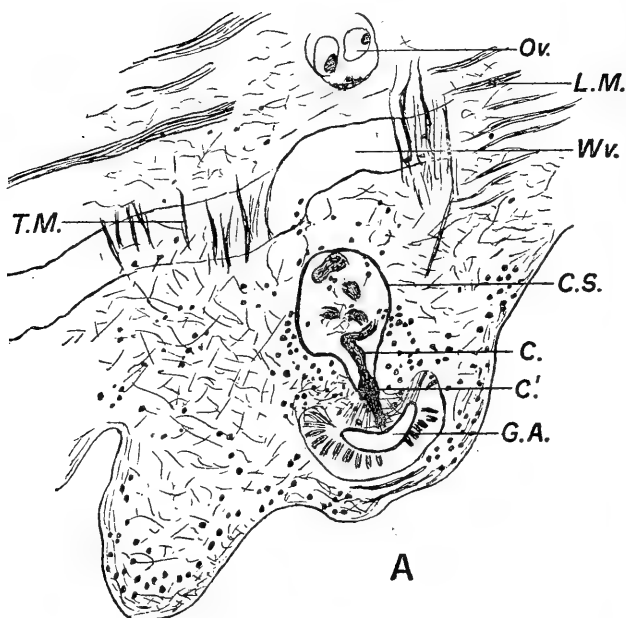
The vas deferens is, in young segments, with difficulty distinguished from the vagina, lying as it does above it, and following an approximately parallel course. Later it lengthens, widens, and becomes very elaborately coiled, at the same time becoming gorged with sperm. It comes to occupy a considerable part of the right side of the segment, its coils being concentrated mainly towards the anterior border.

Distally it passes into a large spherical cirrus-sac, which measures 0.055 mm. in diameter. Within this the duct continues to coil about, and finally passes out on the opposite side, as the cirrus, or male cloacal canal. This projects into the upper portion of a large genital atrium, with thick muscular walls. At the point where it leaves the cirrus-sac, the lumen of the cirrus shows a considerable dilatation, which is always found to be full of sperm. This may perhaps be regarded as serving the purpose of a seminal vesicle, no other organ of that kind, apparently, being present.

Immediately below the male cloacal canal lies the opening of the vagina, which passes inwards from the genital atrium, below the cirrus-sac, curves upwards behind this to pass between the dorsal and ventral excretory vessels, and thence passes, as described, to the ovary.

As the proglottides grow older, the uterus is seen to enlarge at

Text-figure 4.

*Tetrabolhrius strangulatus.*

A. Portion of a horizontal section through a sexually mature segment.

B. Portion of a transverse section passing through a genital atrium and cirrus-sac.

C, Cirrus ("male cloacal canal"); C', dilated portion of cirrus; C.S., cirrus-sac; D.V., dorsal excretory vessel; G.A., genital atrium; L.M., longitudinal muscles; Ov., Ovary; T.M., transverse muscle-fibres; Vag., vagina; V.V., ventral excretory vessel; W.v., excretory canal.

the expense of the ovary. At first it keeps its well-defined crescentic shape, but becomes crammed with ova, and finally expands so as to occupy nearly the whole of the segment. Meanwhile the rest of the genital organs become broken down and disappear, though for a long time the outlines of the now vacant testes can be seen, and the receptaculum seminis and vas deferens are still distinguishable by reason of the spermatozoa contained in them.

General Remarks.

Tetrabothrius strangulatus is distinguished from other members of the genus by some interesting peculiarities, quite apart from its size, which is unusually small.

One of its most distinctive features is the very sharp demarcation of the head from the neck, giving the worm a "strangled" appearance. In other forms the head, behind the suckers, usually passes almost imperceptibly into the neck, and there is not, as in this species, any considerable portion of the head between the posterior border of the suckers and the beginning of the neck.

The small number of testes is also characteristic. As stated previously, they do not exceed 9 in number, and the usual complement is 8. In the majority of species of this genus there are at least 22 testes (according to Fuhrmann). There may be almost any number up to 60, and the number in a given species generally varies slightly, but only in one species hitherto described are there as few as 8 (*T. monticellii* Fuhrm., from *Fulmarus glacialis*. Testes 8-12).

In the general arrangement of its internal organs *T. strangulatus* approaches closely to *T. heteroclitus* Diesing. But this is a considerably larger form, and its testes, though arranged somewhat similarly in a rosette or horseshoe pattern, are much more numerous, and smaller in proportion. Fuhrmann* gives the number as 28, but in some specimens in the British Museum I have counted 43 in several successive segments, and sometimes an even larger number (probably about 50)†.

In conclusion it may be mentioned that hitherto no species of *Tetrabothrius*—nor, so far as I am aware, any other Cestode—has been recorded from *Diomedea irrorata*.

* Proc. Roy. Soc. Edinburgh, xxii. 1899, p. 649.

† The specimens of *T. heteroclitus* referred to are the types of "*Tania diomedæ*" v. Liust. and "*Tania suliceps*" Baird, respectively, both of which Dr. Fuhrmann considers identical with *Tetrabothrius heteroclitus* Dies. After examining specimens of both, in spite of the discrepancy in the number of testes—43 in "*T. diomedæ*"; about 50 in "*T. suliceps*"—I have no doubt that this view is correct.

28. On a Remarkable Case of Affinity between Animals inhabiting Guiana, W. Africa, and the Malay Archipelago. By OLDFIELD THOMAS, F.R.S., F.Z.S.*

[Received April 28, 1914: Read May 5, 1914.]

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In the lower Vertebrates a considerable number of cases are known where there is an undeniable and direct affinity between forms inhabiting the opposite sides of the Atlantic, but among mammals such cases are excessively few, so that the discovery of an additional one deserves a special record. That this case, like the others, may be explainable without recourse to a land-bridge—which there is little reason to believe persisted into mammalian times—does not make it any the less advisable to publish the case, so that it may be properly considered by students of the subject.

Examples of a striking relationship between certain mammals of West Africa and of the Malay region are of course numerous, however difficult to explain quite satisfactorily, but it is noteworthy that the present instance of transatlantic affinity is also one of the best marked of the West Africa-Malay cases, and one that has been often recorded in that connection.

This is the case of the Pigmy Squirrels, of which there are some half dozen species in the Malay Archipelago, while a single form—*Sciurus minutus* Du Chaillu, the basis of my genus *Myosciurus*—inhabits Western Africa. Of the close relationship of *Myosciurus* to the Eastern *Nannosciurus* there can be no doubt whatever.

In 1789 Buffon described ‡ a little squirrel from Cayenne as “Le petit Guerlinguet,” a technical name, *Sciurus pusillus*, being attached to it by Desmarest later on. Then in 1867 Gray described a small squirrel bought from the dealer Parzudaki and said to have been collected by Castelnau in Brazil, as *Macroxus kuhlii*, and this was, and I believe rightly, synonymized with *S. pusillus* by Alston and other authors. Probably the specimen was not collected by Castelnau at all, but was accidentally included with Castelnau specimens by Parzudaki.

The skulls, both of this specimen and of another which was obtained by Mr. H. C. Rothery in Cayenne in 1845, were unfortunately so broken that no proper judgment on the characters

* Published by permission of the Trustees of the British Museum.

† [The complete account of the new genus described in this communication appears here, but since the name and a preliminary diagnosis were published in the “Abstract,” No. 133, 1914, the genus is distinguished by the name being underlined.—ED.]

‡ Hist. Nat. Supp. vii. p. 263, pl. 66.

of the animal could be obtained from them, and merely on the basis of its small size and its possession of five cheek-teeth it has been placed in *Microsciurus*, a group of true squirrels found in Central and North-western South America.

Now at last the Museum has received from Mrs. McConnell, widow of the late Mr. F. V. McConnell, so long and frequent a contributor to the Museum collections, three specimens of the Guianan Pigmy Squirrel, one of them with a practically perfect skull.

An examination of this skull shows that instead of being in any way related to *Microsciurus* or other forms of American Sciurinae, the Guiana Squirrel is a member of the Nannosciurinae, in which it forms a special genus closely related to *Nannosciurus*. This genus may be diagnosed as follows:—

SCIURILLUS.

Abstract P. Z. S. 1914, p. 36 (May 12th).

General structure of skull and number of teeth as in *Nannosciurus*, agreeing with that genus and differing from *Myosciurus* in all the characters recorded by me* as distinguishing these genera from each other. An ectopterygoid present, broad, but not so long as in *Nannosciurus*.

Postorbital processes over posterior root of zygoma. Interorbital space as broad as the brain-case. Zygomata very broad and strong. Anteorbital foramen small, far in front of the teeth, as in *Nannosciurus*, its opening continued upwards as a peculiar curved groove along the front edge of the anteorbital fossa.

Cheek-teeth $\frac{5}{4}$, as in *Nannosciurus*. Molars low, as in other Nannosciurinae, their set normal, as in *Nannosciurus*, the last molar not facing outwards as in *Myosciurus*. Their upstanding cusps, both above and below, very little developed. Their surface more smoothly basin-shaped, with less evident transverse ridges.

Type. *Sciurus pusillus* Desm.†

As a genus, *Sciurillus* is very closely related to *Nannosciurus*, the reduction in the prominent transverse ridges of its molars, the peculiar structure of its anteorbital foramina, and its high but abruptly truncated ectopterygoids being its chief distinguishing characters. From *Myosciurus*, though both are undoubtedly of the same group, it is more widely separated.

In presenting this highly interesting case to students of geographical distribution, I may point out that the whole of North America is full of Squirrels of the other subfamily, the Sciurinae, and that these have penetrated into South America as

* Ann. Mag. N. H. (8) iii. p. 474 (1909).

† Should any doubt be thrown on the determination of *Sciurus pusillus*, the genus should be considered as founded on the species represented by the type of *S. kuhlii*.

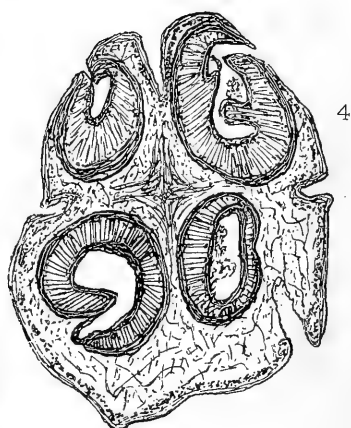
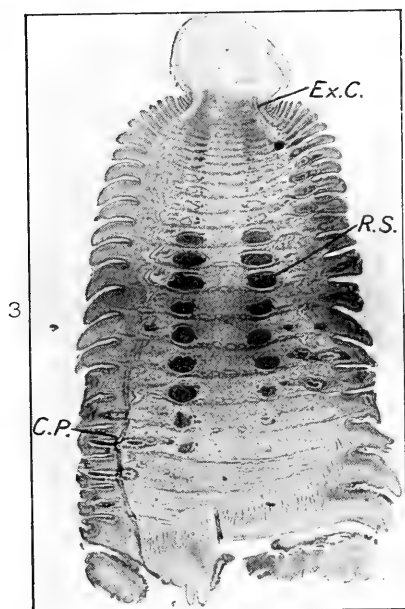
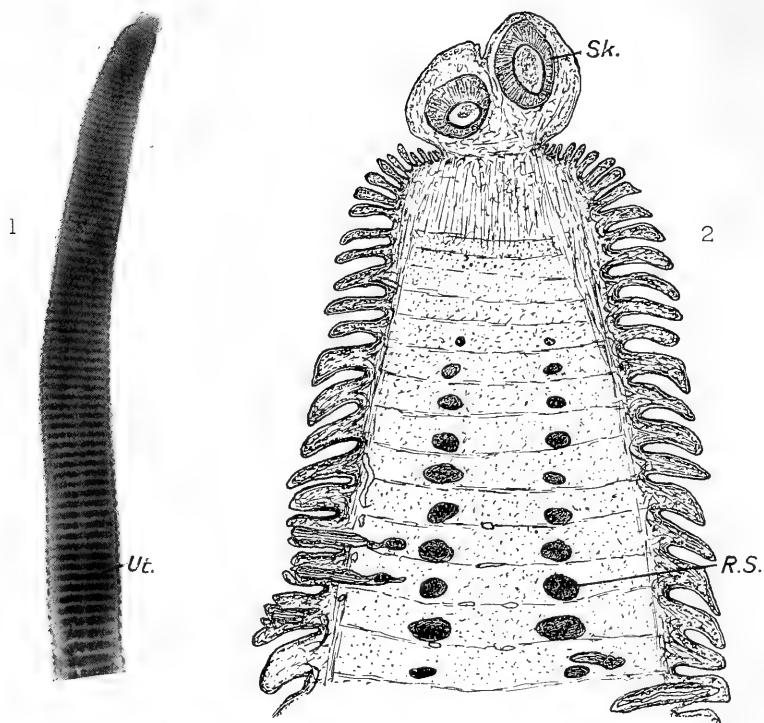
far as the tropic of Capricorn, and Sciurinae cover the whole of Europe, North Africa, and the continent of Asia, the Nannosciurinae being in the Old World rigidly restricted to a small part of West Africa and to the Malay Archipelago. The addition of Guiana to the known distribution of the group is therefore of extraordinary interest.

Here, if ever, there would seem to be a case supporting the persistence of the now generally admitted * transatlantic connection into mammalian times, but bearing in mind how other cases—such as those of the Tapirs and Opossums—have become weakened by the discovery of fossil members of the groups in N. America, Europe, and N. Asia, it would be wise not to lay too much stress upon it, isolated and absolutely tropical as are the three genera of Nannosciurinae.

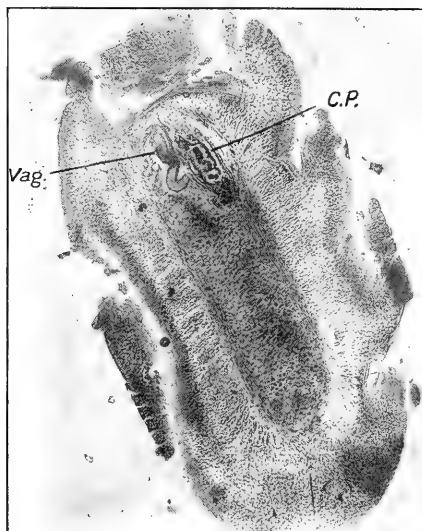
Moreover, the fact that in every character which separates the other two, the Guianan *Sciurillus* agrees with the Malay *Nannosciurus* and not with the African *Myosciurus*, is also against this case having any connection with the ancient "Gondwana-land," which at a time almost or quite pre-mammalian is supposed to have extended from Eastern S. America across Africa into the Malay region.

* Cf. Andrews, 'Tertiary Vertebrata of the Fayum,' Introduction, p. xxvi (1906).

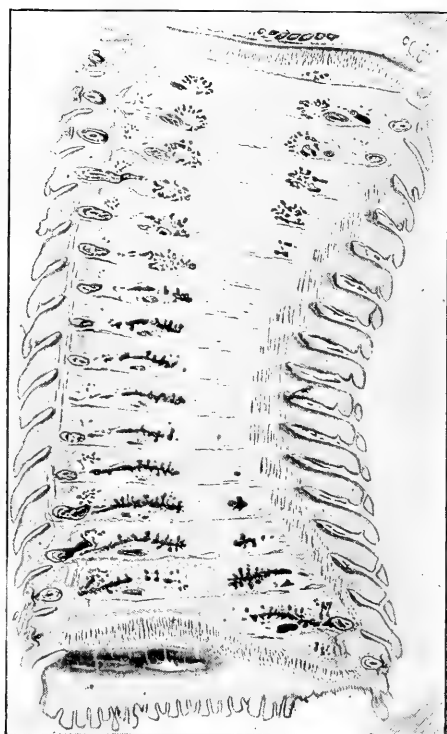




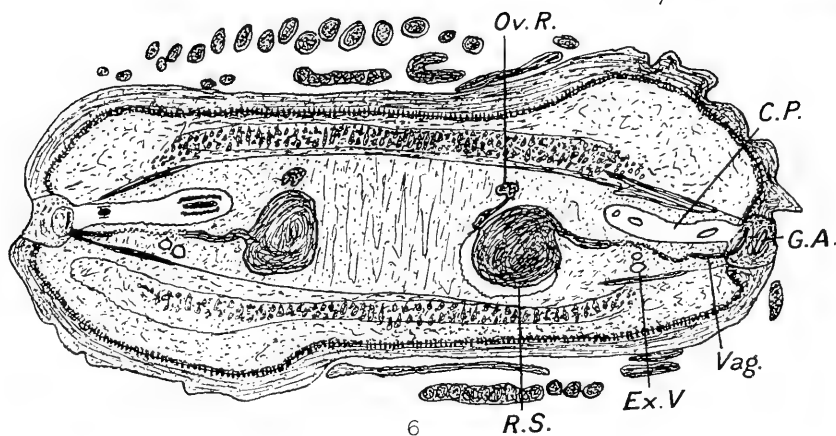
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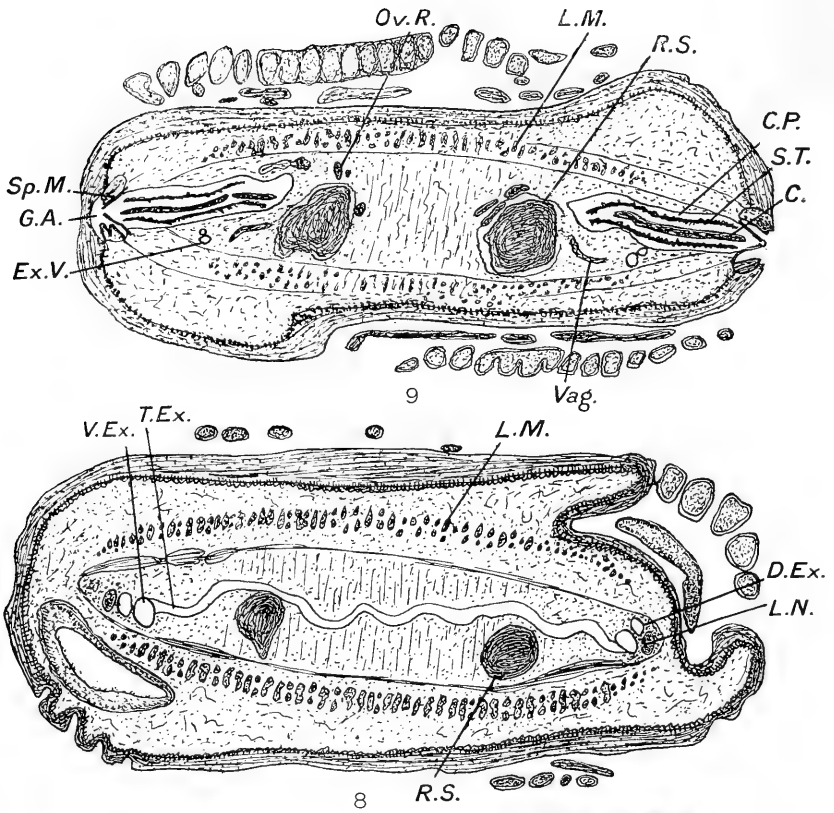


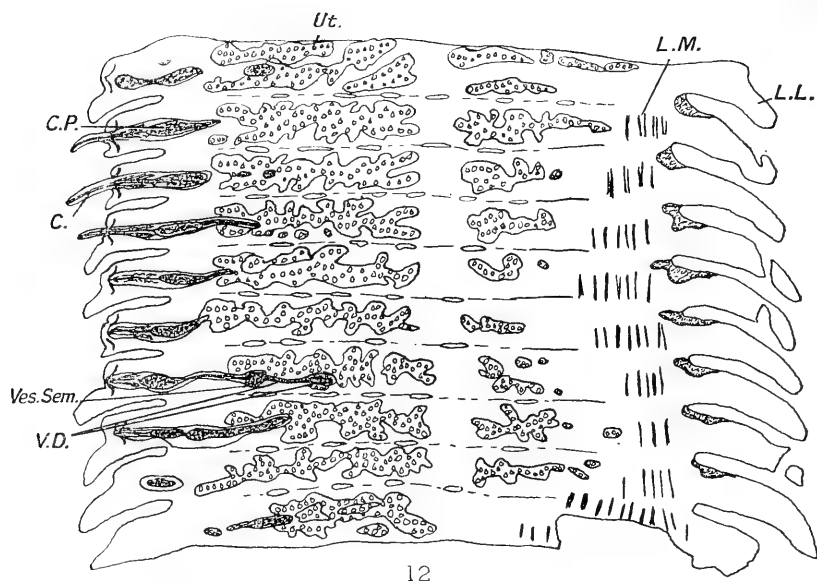
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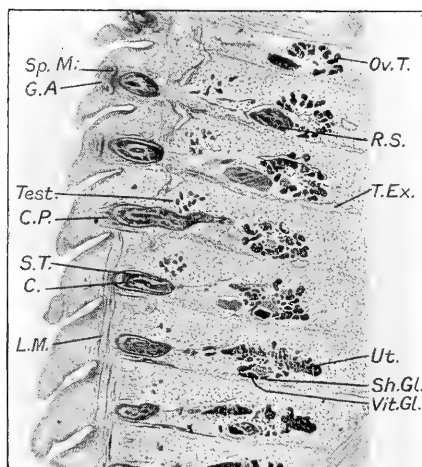
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CITTOTÆNIA LAGORCHESTIS.

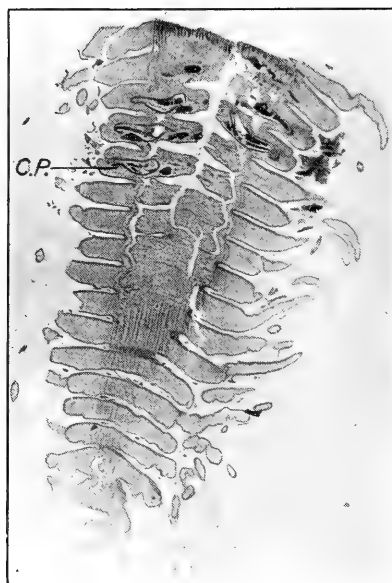




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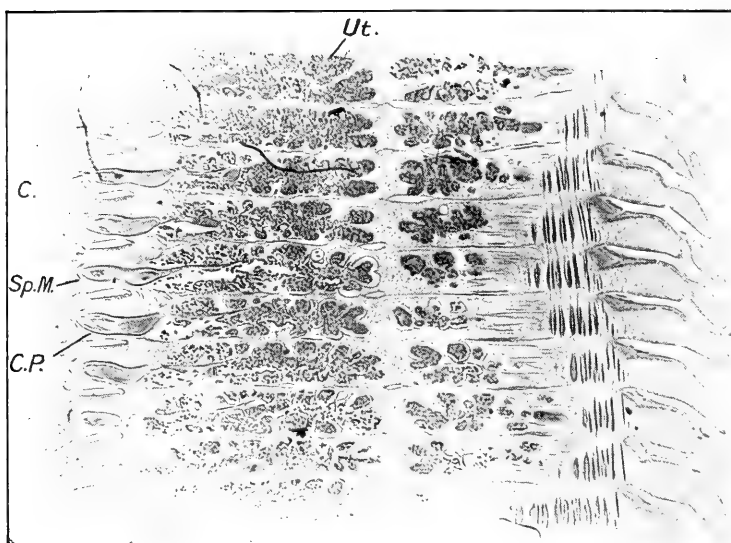


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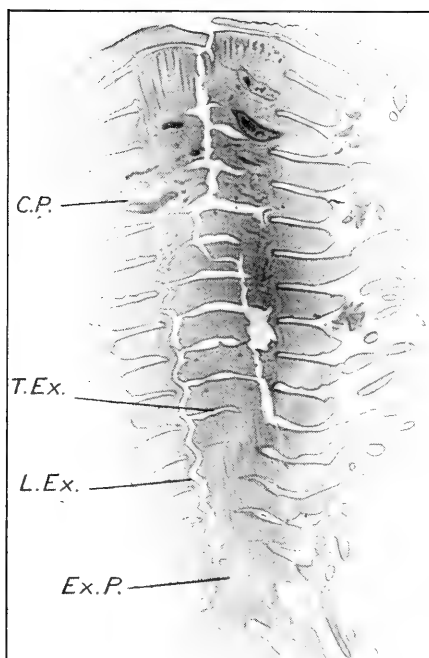


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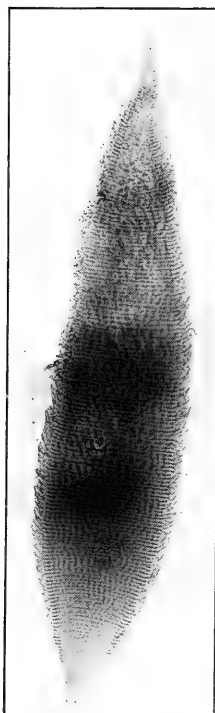
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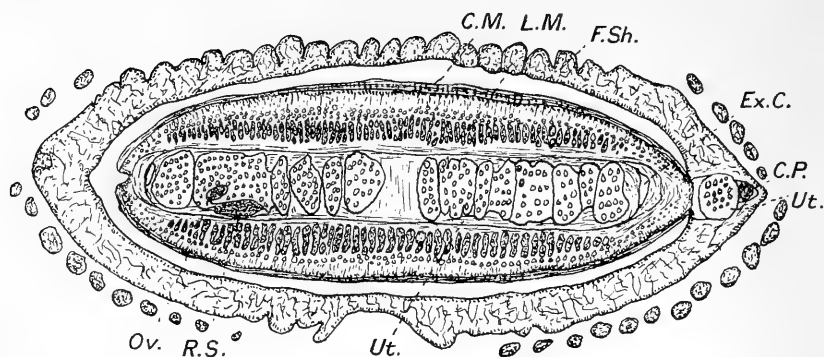


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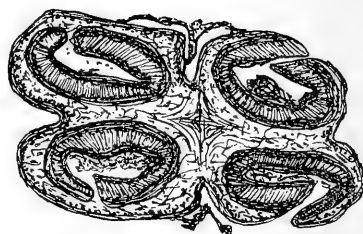
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14, 15. CITTOTÆNIA LAGORCHESTIS.

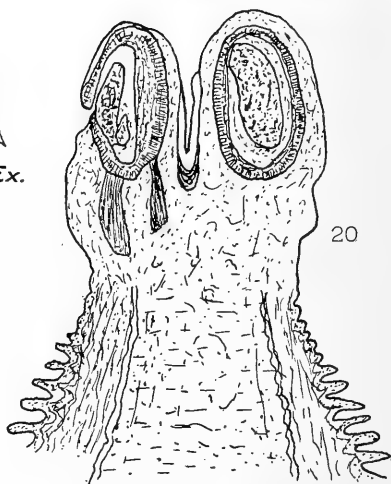
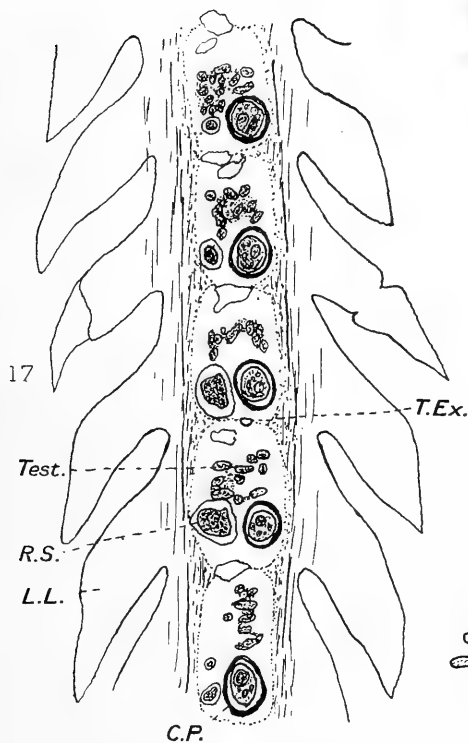
16. CITTOTÆNIA VILLOSA.



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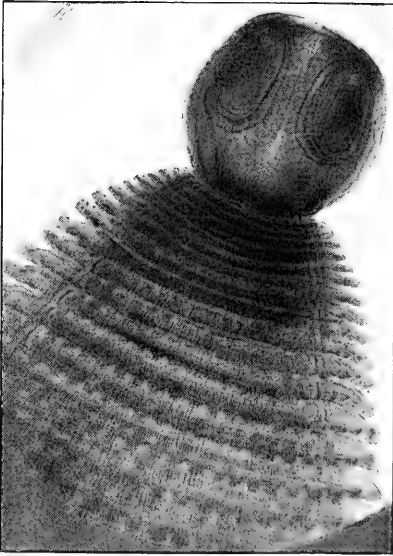
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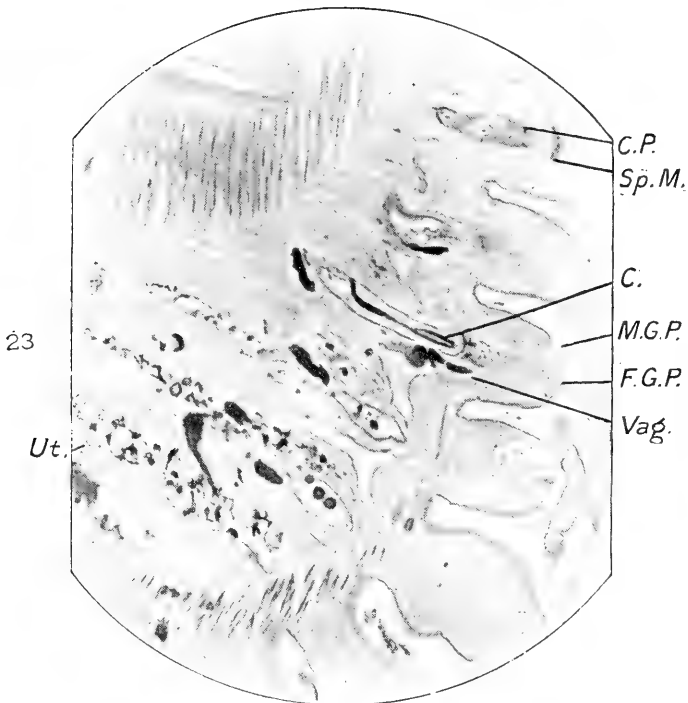
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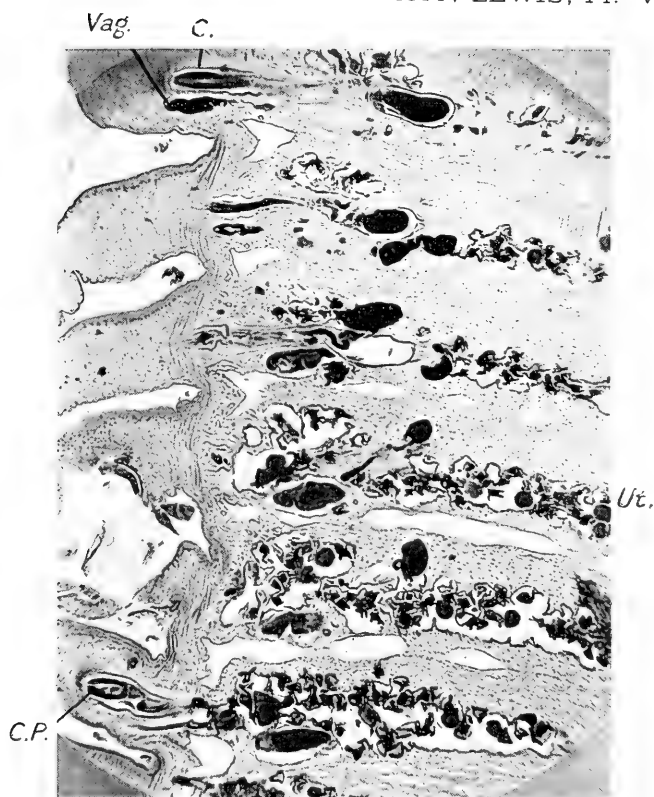


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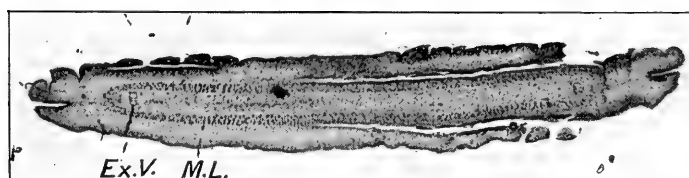


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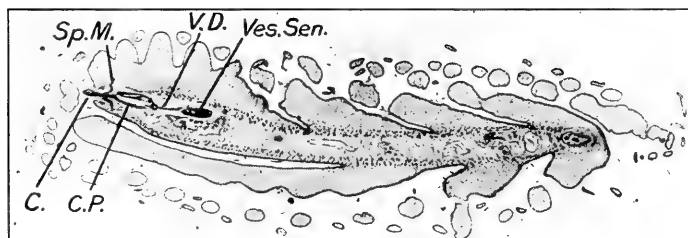
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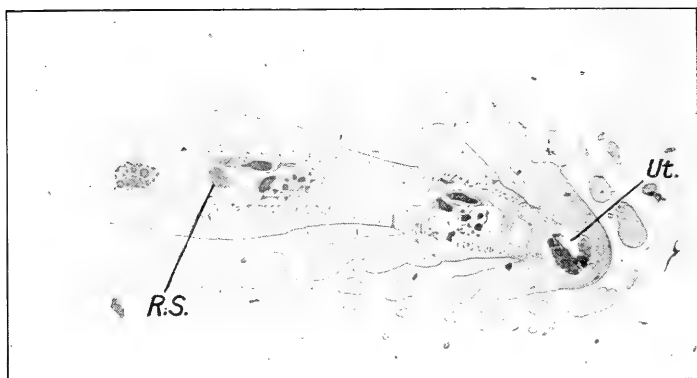
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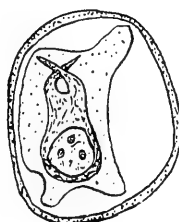
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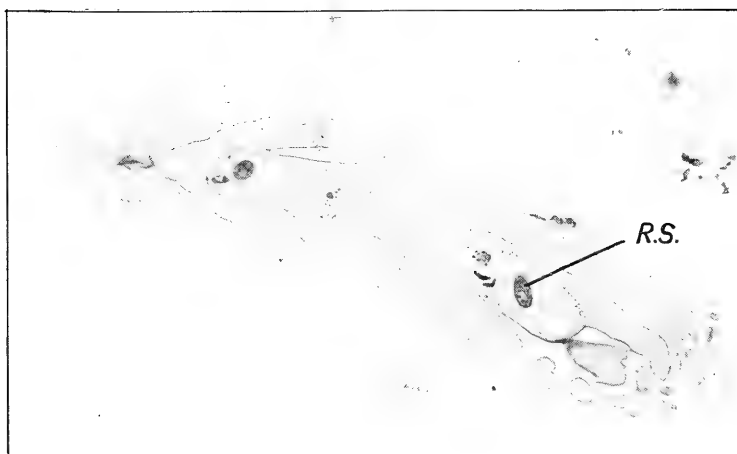
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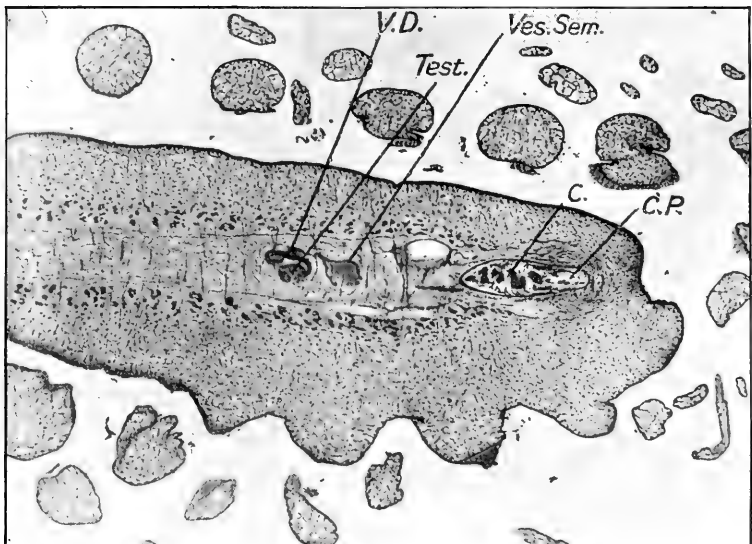


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CITTOTÆNIA VILLOSA.



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29. On Two New Species of Tapeworms from the Stomach and Small Intestine of a Wallaby, *Lagorchestes conspicillatus*, from Hermite Island, Monte Bello Islands. By R. C. LEWIS, M.A. (Cape), (1851 Exhibition Scholar) *.

[Received March 17, 1914: Read May 5, 1914.]

(Plates I.-X. † and Text-figures 1-3.)

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I am indebted to Mr. P. D. Montague, Caius College, Cambridge, for this material obtained by him on the recent expedition to the Monte Bello Islands. The parasites come from the intestine and stomach of a species of Wallaby, *Lagorchestes conspicillatus*, found only on two or three of the Monte Bello Islands. The specimens were compared with those in the collection at the Berlin Museum, thanks to the courtesy of Dr. A. Collin, who kindly assisted in comparing these species with those in the Museum, including Rudolphi's collection. A comparison was also made with the collection in the British Museum (Natural History), where *Cittotænia pectinata* Goeze (21 & 25) and *Cittotænia denticulata* Rudolphi (21) were examined, and no specimens bearing any resemblance to the species under discussion were seen in the collection at the Zoological Gardens or at the London School of Tropical Medicine.

Both species are characterized by the presence of two sets of genital glands and two lateral genital pores to each segment. The genital canals cross the longitudinal canals and nerves dorsally. Interproglottidal glands are absent, and there are no calcareous bodies. They belong to the genus *Cittotænia* Riehm. The history of the genus is of some interest, and is discussed by Stiles and Hassall (26) and by Lyman (21). Riehm (23 & 24) established the genus in 1881, but later rejected it, placing his type *Cittotænia latissima* Riehm in the genus *Dipylidium* Leuck. In 1891 Blanchard included double pored leporine cestodes in the genus *Moniezia*, taking *Tænia expansa* Rudolphi as his type. Later, 1893, Railliet included these forms in the genus *Ctenotænia* with *Tænia marmotæ* Frolich as type. It was not until 1896 that the genus *Cittotænia* was re-established by Stiles and Hassall with the following characteristics:—Anoplocephaline cestodes with segments broader than long and longer than thick, end segments in some cases becoming longer and narrower. Two full sets of genital glands and two lateral genital pores to each segment; generally

* Communicated by Prof. E. W. MACBRIDE, F.R.S., V.P.Z.S.

† For explanation of the Plates see pp. 431-433.

one, sometimes two, simple transverse tubular uteri in each segment, uterus generally with proximal and distal diverticula. Vagina ventral to cirrus-pouch on both sides of segment. Dorsal canal usually between ventral canal and nerve. Genital canals cross longitudinal canals and nerves dorsally. Interproglottidal glands absent. Calcareous bodies not yet recorded. Eggs with well-developed pyriform bodies, the horns of which are long and filamentous, crossing each other. Riehm based his diagnosis on the noteworthy spread of the excretory system, which is not ladder-like, but consists of three to five chief side stems and numerous net-forming branches; on the double reproductive organs, which open on the projecting lateral borders of the segments; and on the head appearing pushed-in in front and hookless.

Blanchard's diagnosis of the genus *Moniezia* differs from that of *Cittotenia* in that on the right side the vagina is ventral to the cirrus-pouch and on the left side dorsal. Interproglottidal glands present, and the horns of the pyriform body do not cross, and end in a disk. The genus *Thysanosoma*, founded by Diesing, 1835, contains double pored cestodes very similar to those included in the genus *Cittotenia*, but differs in that the genital canals cross the ventral canals and nerve dorsally and the horns of the pyriform body are absent. There is one transverse undulating uterus, and forms with one set of genital glands and one genital pore are also included. Stiles states that from the analysis of characters *Cittotenia* forms a genus intermediate between *Moniezia* and *Thysanosoma*. The first of the species now to be described was at first thought to belong to the genus *Thysanosoma* Dies., resembling most closely *Thysanosoma fimbriata* Dies., but it was found that the genital canals cross the excretory canal and nerve dorsally, and that the species shows considerable resemblance to *Cittotenia zschokkei* von Janicki (10) and agrees with this species in the absence of the pyriform body. Von Janicki therefore holds that the generic diagnosis of the genus *Cittotenia* should be altered from pyriform body present to pyriform body present or absent. Von Linstow in his description of *Cittotenia quadrata* (20) describes and figures the vagina running out and opening dorsal to the cirrus-pouch, and does not state that this is contrary to the normal occurrence in the genus. It is evident from the large number of synonyms for each species, and from the departure from the generic characteristics in some of the original descriptions, that the genus *Cittotenia* requires revision. The two species from the Wallaby show the generic characteristics as described for the genus *Cittotenia* by Stiles and Hassall (26) and are therefore included in that genus.

CITTOTENIA LAGORCHESTIS, sp. n. (Pls. I.-IV.; V. figs. 14, 15; VI. figs. 17, 18.)

The specimens vary in length from 40-60 mm. and the greatest breadth is 4 mm. There are usually about 150 proglottides.

The strobilæ are uniform in breadth save at the anterior and posterior extremities, where they become narrower. The scolex is .6 mm. long by .75 mm. broad. The proportion of breadth to length in young segments is as 1 to 3, in older as 1 to 6. The scolex is rounded with no rostellum and no hooks. It is set on the top of the strobila like a dome-shaped knob. There are four oval suckers. Each of the four is .35 mm. long by .25 mm. broad. There is no neck, and the proglottides commence immediately behind the head (figs. 2 & 3); each of them possesses a well-marked projection at its hinder border which overlaps half of the succeeding proglottis. The edges of these projections are fimbriated, showing an even serration which gives the animal an ornamented appearance resembling the condition found in *Thysanosomea fimbriata* Dies. (22). The genital pores are found in the middle of the projecting lateral margins of the segment. The cirri are often seen projecting from the pores (figs. 12 & 14). The musculature does not present any marked peculiarities. It is like the structure described for *Cittotenia zschokkei* von Janicki (10), where the musculature forms numerous fine-threaded bundles. The subcuticular layer consists of well-developed longitudinal and transverse muscular layers. There is also a system of sagittal fibres which run dorso-ventrally, forming a dense network of fibres between the transverse plates. They branch greatly and these branches form a network around the testes and various female glands. There is a ventral and a dorsal longitudinal excretory canal on each side. The ventral canal is large, thin-walled, and seldom circular in cross-section. The dorsal canal is smaller and circular. It has a thick cuticular lining around which is a layer of muscle-fibres. All the canals unite in the head, forming an anterior loop between the suckers. The ventral canals are connected in the posterior portion of each proglottis by a transverse canal. There are no secondary longitudinal canals connecting the transverse canal as described for *C. pectinata* Goeze. The excretory system so far resembles that in *C. variabilis* Stiles (21). On the terminal segment the canals open by a simple pore situated towards the anterior end of the proglottis (fig. 15). The large ventral canal discharges by simple transverse tubes into this pore. There is no reservoir as described for *C. pectinata* Goeze (21), nor is there a projection of the parenchyma into the ventral canal at the posterior end of each segment, as described by Fuhrmann in *C. kuvaria* Shipley (7). The first rudiments of the genital organs appear in the proglottides immediately behind the head (fig. 3). There are two sets of genital glands in each segment (fig. 7), and two uteri in the early segments up to the 80th segment, where they meet in the median field, and it appears as if there were only one uterus (fig. 1). The uteri possess proximal and distal diverticula. Very young segments in which the reproductive organs are in their first rudiments, show the vagina running out to open into the genital atrium posterior to the cirrus (figs. 5 & 6).

The vagina is a thick-walled tube with a narrow lumen. It is connected with a very large receptaculum seminis. With increasing age, before the ovary is functional, the vagina atrophies from the pore inwards, and finally, when female and male canals are fully developed, the vagina remains only as a small tubular projection from the receptaculum (figs. 9 & 11). This resembles the condition found in *C. zschokkei* von Janicki (10), and von Janicki concludes that the young proglottides, whose testes are not yet developed, function as females, and that the older proglottides with abortive vaginae function as males, although the female organs are otherwise fully developed. The eggs must all be fertilized by the sperm stored up in the receptaculum seminis, which receives sperm through the vagina from the same worm or from another worm by copulation in the young state, and this is proved by the fact that the receptaculum of proglottides in which testes are not yet developed are filled with spermatozoa.

Male Reproductive Organs.

The first rudiments of the testes are seen about the 12th segment. They reach maturity about the 60th segment, and are seen as small rounded sacs lying in the dorsal field of each segment between the transverse excretory canal of the preceding segment and the cirrus-sac (figs. 7 & 11). They do not extend in towards the median field as in *C. kuvaria* Shipley (7), but are confined to the dorsal region between the ventral excretory canal and the inner termination of the cirrus-sac. From these testicular sacs, about 50 on each side, little ducts are given off which connect with the vas deferens. The vas deferens is a slender duct which runs in towards the median field and then loops back above the receptaculum seminis to run obliquely down to the cirrus-pouch. The vas deferens does not extend further towards the median field than the inner extremity of the receptaculum seminis. Before entering the cirrus-pouch there is a circular swelling, the vesicula seminalis, with a diameter of .1 mm. and a thick wall. The cirrus-pouch is elongated and of uniform size and thickness in mature segments, 1 mm. long by .2 mm. broad (figs. 9 & 11). It has muscular walls consisting of an outer longitudinal layer and an inner thicker circular layer. The cirrus also has circular and longitudinal fibres. The space between the muscular wall of cirrus-sac and cirrus is filled with spongy tissue. The cirrus is thick-walled with a narrow lumen. It is often seen protruding to a great extent, nearly as far as the length of the cirrus-pouch. It is covered externally with closely set bristles. The outer end of the cirrus-sac discharges into a space, the genital atrium. Its outer end is guarded by a circular muscular sheath, the sphincter; and beyond this sheath, in the genital atrium, is a circular projection of the floor of the latter.

Testes are not observed after the 100th segment, though the cirrus-sac persists to within twelve segments of the posterior

extremity. In this respect this species differs from *C. pectinata*, where the testes are described as persisting to the last proglottis.

It is noteworthy that in this species at the tapering posterior extremity no genital glands are observed in the last 12-15 segments (figs. 13 & 15).

Female Reproductive Organs.

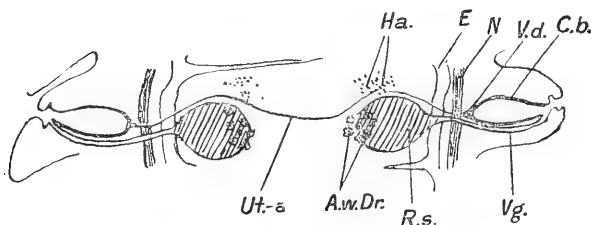
These appear earlier than those of the male. The first rudiments of the genital glands are found in the segments immediately behind the head (fig. 3). The vagina opens to the exterior up to the 25th segment, but after that aborts from without inwards. The receptaculum is prominent from the first and persists throughout the strobila, except in the last 12-15 segments where, as already mentioned, no genital glands are observed. The ovary is rudimentary up to about the 40th segment, where it takes on its mature form, and at about the 50th segment the first traces of the uteri are seen. After the 100th segment all of the female organs except the uterus begin to atrophy, and in the posterior segments only the uterus and receptaculum seminis persist (figs. 12 & 14). The vagina, only complete in the early segments, runs out ventral to the cirrus-pouch and opens into the genital atrium posterior to cirrus (fig. 6). At its distal end the lumen is very small and the cuticular lining very thick. In the region beneath the cirrus-pouch it is surrounded by deeply staining cells as in *C. variabilis* Stiles (21), and in this region has numerous bristles on its walls. It is a straight tube, and runs in to open into the large receptaculum seminis. The receptaculum seminis is elongate, .2 mm. long by .1 mm. broad. It is surrounded by a thin layer of circular muscle-fibres, and outside the fibres is a single layer of cells which stain deeply. The ovary consists of a number of "Indian club" shaped pouches. Each pouch opens into a common reservoir by a narrow neck (fig. 10). The oviduct runs from the reservoir of the ovary towards the yolk-gland. Beyond the opening of the vitelline duct into the oviduct, the latter passes through the shell-gland and enters the uterus at a spot situated just below the ovary. The ovary is situated dorsal to the receptaculum. Its outer tubules overlap the receptaculum, but the inner tubules are slightly nearer the median field. Ventral to the ovary and near the posterior margin of the segment is the small vitelline gland. Alongside it, towards the median field, is the comparatively large shell-gland (fig. 11). The duct from the receptaculum seminis opens into the reservoir of the ovary at the side nearer the margin.

The uterus is formed dorsal to the ovary. The female genitalia are crowded close together. The uteri, at first separate, gradually extend towards the median field, and their blind ends become closely applied, so that in older segments it is difficult to distinguish two uteri. The uterus does not cross the longitudinal canals and nerves, but in older segments pushes them nearer the

margin. It is possessed of numerous proximal and distal diverticula. As already mentioned, the egg possesses no pyriform body.

The nervous system has not been worked out, as the specimens were fixed in alcohol, but from the sections it appears that the condition is like that in *C. quadrata* von Linstow (20), with a single trunk on each side to the outside of and dorsal to the two excretory canals, and a ganglionic mass is observed beneath the loop formed by the excretory canals in the head.

Text-figure 1.



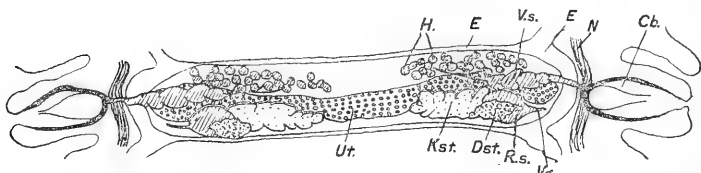
C. zschokkei von Janicki. Young already fertilized proglottis in optical section, from von Janicki (10), p. 130. $\times 45$.

A.w.Dr., rudiments of female genital ducts; *C.b.*, cirrus-pouch; *E*, excretory vessel; *Ha.*, rudiments of testes; *N*, longitudinal nerve; *R.s.*, receptaculum seminis; *Ut.a.*, rudiments of uterus; *V.d.*, vas deferens; *Vg.*, vagina.

Affinities and Contrasts with other Species.

In describing this species it has already been pointed out that of all the species of *Cittotenia* this one resembles most closely *C. zschokkei* von Janicki (10). The chief points of resemblance are the possession by both species of a projecting sheath, which is

Text-figure 2.



C. zschokkei von Janicki (10). p. 130. Ripe proglottis in optical section. $\times 45$.

Dst., vitelline gland; *H.*, testes; *Kst.*, ovary; *Ut.*, uterus; *V.s.*, vesicula seminalis. Other lettering as in text-fig. 1.

fimbriated, at the posterior border of each segment overlapping half the next segment: also the development and position of the reproductive organs; the absence of the pyriform body in

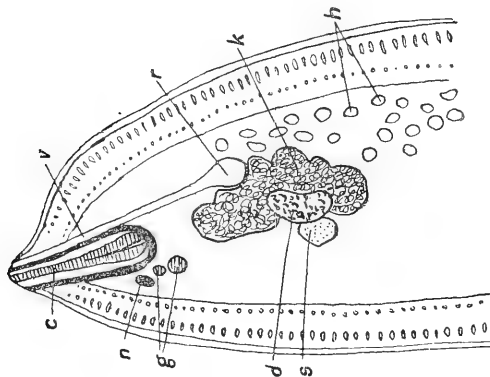
the egg ; the large receptaculum seminis, and the vagina aborting in later segments. There are, however, important points of difference which mark *C. lagorchestis* as a distinct species. In the first place, there are only two longitudinal excretory canals and one transverse excretory canal in each segment in *C. lagorchestis*, whereas in *C. zschokkei* there are three longitudinal excretory canals and two transverse canals to each segment. The most important contrasts are found in the reproductive organs, and may be tabulated as follows :—

<i>C. lagorchestis.</i>	<i>C. zschokkei.</i>
(1) Vas deferens a slender tube with an oval swelling, the vesicula seminalis, near entrance into cirrus-sac. Vas deferens recurves to receive ducts from testes.	Vas deferens much swollen throughout its length to form an elongate vesicula seminalis. Vas deferens passes straight to testes.
(2) Cirrus-pouch extends across the longitudinal canals and nerve towards the median field for half its length.	Cirrus-pouch does not extend inwards over excretory canals and nerve.
(3) Testes situated dorsal to projection of cirrus-pouch in inner parenchyma between ventral longitudinal excretory canal and inner termination of cirrus-pouch.	Testes more median, situated dorsal to ovary, receptaculum seminis, and vitelline gland, and not extending outwards to longitudinal excretory canal.
(4) Ovary dorsal to receptaculum seminis, and consisting of a circle of "Indian club" shaped tubules opening into a common reservoir by slender necks.	Ovary on same plane as receptaculum seminis, nearer median field consisting of an irregular mass not showing tubular arrangement.
(5) Two uteri, whose origin is distinct as separate tubules, but which with increasing age approach each other and fuse in the median field.	Uterus originates as a single tube.

The only resemblance with *C. kuvaria* Shipley (7) is that the cirrus-pouch is much elongated and stretches over excretory vessels and nerve into the inner parenchyma. Also there is a large shell-gland in both species, and in ripe proglottides the uterus fills the whole of the inner parenchyma, not extending over the excretory canals and nerves but pushing these nearer the margin. The contrasts are well marked. In *C. kuvaria* the excretory system consists of extraordinarily wide channels, two large ventral and one smaller dorsal vessel, and the hind end of each proglottis shows a tongue-like projection of parenchyma into ventral vessel which lies on a projection of the wall of the latter and forms a barrier which prevents a backward flow of excretory fluid. No such structure is observed in *C. lagorchestis*.

Although the male organs are doubled the testes are not clearly divided into two groups. They are united in the median field of the proglottis. In *C. lagorchestis* there are two distinct groups lying in dorsal anterior field of segment, next to ventral excretory canal, and not spreading further towards median field than the inner border of the cirrus-pouch or the outer border of the receptaculum seminis. In *C. kuvaria* the ovary is ventral and the vitelline gland dorsal, while in *C. lagorchestis* the ovary is dorsal and the vitelline gland ventral. There is a single uterus, and the receptaculum is covered with a star-shaped epithelium in *C. kuvaria*. In *C. lagorchestis* the uterus is double, and there is no star-shaped epithelium covering the receptaculum seminis.

Text-figure 3.



Transverse section through a lateral portion of *Cittotania quadrata* von Linstow, from (20) fig. 3, p. 680. c, cirrus; n, nerve; g, excretory vessels; d, vitelline gland; s, shell-gland; v, vagina; r, receptaculum seminis; k, ovary; h, testes.

C. quadrata von Linstow (20) shows very little resemblance with *C. lagorchestis*. There are two longitudinal excretory vessels, a larger ventral and a smaller dorsal, and a longitudinal nerve dorsal to these, as in *C. lagorchestis*. The chief points of contrast are that the vagina runs out and opens dorsal to the cirrus in *C. quadrata*; the receptaculum is small and dorsal to the ovary; the shell-gland is ventral to the vitelline gland, and the testes are dorsal to the ovary and extend in towards the median field. The eggs are four-sided and possess a pyriform body, and there is a single uterus.

C. pectinata Goeze (21 and 25) was examined at the British Museum (Natural History). The head is not sharply marked off from the strobila as in *C. lagorchestis*, nor are the suckers, which are set on the rounded anterior extremity, so large and prominent. The lateral margins of each segment are rounded and not

projecting as in *C. lagorchestis*. There is also a slight rostellar-like projection at the anterior end of the scolex. The posterior projecting border of each proglottis is smooth and only slightly overlaps the following segment, and the cirrus is never found protruding from the pore. There are secondary longitudinal canals uniting the transverse excretory canals. In the posterior proglottis the excretory canals open into a reservoir which opens at the excretory pore through many canals. The testes do not disappear, but are found in the posterior proglottis grouped round the excretory pore. There is an enlargement just inside the cirrus-pouch filled with sperm, the vesicula seminalis, and there are two seminal receptacles, a smaller external and a larger internal sac. There is a single uterus which extends over excretory canals and nerves into the lateral margins. The horns of the pyriform body are long and filamentous. The above points are in marked contrast with *C. lagorchestis*.

Cittotænia denticulata Rudolphi (25) was also examined at the British Museum (Natural History), and differs from *C. lagorchestis* chiefly in that the testes are in two groups in the lateral portion of the median field. The cirrus-pouch is short and does not reach the longitudinal nerve. There is a single uterus, and in ripe proglottides it extends over the longitudinal canals and nerves into the lateral margins.

These contrasts suffice to show that *C. lagorchestis* is a distinct species. It has been compared in the same way with all the described species mentioned in the Index Catalogue (27) and in the Zoological Record, and the disparity has been sufficient to indicate that it is a new species.

CITTOTÆNIA VILLOSA, sp. n. (Pls. V. fig. 16; VI. figs. 19, 20; VII.—X.)

These specimens have a leaf-like strobila and the shape resembles a large liver-fluke (fig. 16), being widest near centre and gradually tapering towards both extremities. The posterior proglottides become narrower but not longer, and thus differ from *C. pectinata* Goeze (21), in which species they also become longer. The length varies from 40–80 mm. and the greatest width is 6 mm. The number of proglottides in strobila vary from 120–200. The proportion of breadth to length in youngest proglottides is 1:3, in older 1:8. The scolex stands out from the anterior end of the strobila like a truncate cone (fig. 21). It is 8 mm. long by 6 mm. broad. The suckers are large and conspicuous and set on the widest part of the head. They are 3 mm. broad by 4 mm. long. There is no rostellum or hooks. In transverse section the head appears quadrate with rounded corners. The suckers occupy the four corners and nearly meet in the median line (fig. 19). In *C. lagorchestis* the head appears circular in transverse section (fig. 4). There is no neck, and the proglottides commence immediately behind the head.

In this species the posterior borders of the proglottides have a backwardly projecting sheath with more markedly fimbriated

posterior border than in *C. lagorchestis* (figs. 16, 22). The fimbriation is in the form of a regular serration in the earlier proglottides (fig. 21), only overlapping half the succeeding proglottis, but in older proglottides these fimbriations are much elongated to form a mass of elongate hair-like projections which cover two or three of the succeeding proglottides. These projections become more elongate towards the posterior end and project 4 or 5 mm. beyond the posterior segment (fig. 16). In no described *Cittotænia* is this sheath from the hind border of each proglottis broken up at its free edge in such a marked degree into hair-like lappets which project so far backwards over the succeeding proglottides.

Considerable difficulty was experienced in working out the internal structure of this species, because several of the strobilæ were mounted whole, and no trace of reproductive organs was observed in any of the proglottides (fig. 16). This was confirmed by series of sections throughout the strobila, which showed absence of reproductive organs (fig. 25). This was the more remarkable, in that the specimens without reproductive organs were not smaller in size, nor did they have fewer segments than those found with reproductive organs.

In the forms found with reproductive organs no trace of these was to be seen in the first 50 segments, after which an abrupt transition was met with and proglottides were found with reproductive organs. The reproductive organs reach maturity very rapidly, and very few segments contain them in a rudimentary state.

Again, after the 120th segment no reproductive organs were found. The segments with reproductive organs therefore were situated in the median portion of the strobila. This is in contrast with all other species of *Cittotænia*, where the first rudiments of the reproductive organs appear in the segments immediately behind the head.

The musculature is similar to that described for *C. variabilis* Stiles. The sub-cuticular layer, consisting of longitudinal and transverse layers, is especially well developed. The excretory system appears also to agree with the condition found in *C. variabilis*, but no reservoir was detected on the posterior proglottis, and the ventral canals discharge by a simple pore on the last proglottis, as in *C. lagorchestis*. The ventral canal is especially large and occupies a large part of the lateral field. One main longitudinal nerve trunk is present on each side dorsal to the two excretory vessels, but the details of the nervous system could not be determined in these specimens killed and fixed in alcohol.

Male Reproductive Organs.

There is only one testis-sac on each side, which is large, .4 mm. in diameter, and filled with a mass of developing sperm clusters (figs. 30 & 31). It is situated in the dorsal anterior field of each segment, a little nearer the median field than

the inner border of the receptaculum seminis. The vas deferens is coiled, and loops first towards the median field and then dorsally back towards the margin. A large part of the vas deferens is swollen to form an elongate vesicula seminalis as in *C. zschokkei* von Janicki (10). The vas deferens passes obliquely downwards to the cirrus-sac. The cirrus-pouch is even more elongate than in *C. lagorchestis*, 1.4 mm. long but not quite so broad. It is possessed of the same musculature on its wall as in *C. lagorchestis*, and the cirrus is also thick-walled with a muscular wall, a narrow lumen, and is covered with numerous bristles. Also, between the wall of the cirrus-sac and the cirrus is a mass of spongy tissue. In a few cases the cirri are seen protruding from the male genital pore (fig. 26), but in most cases cirrus and cirrus-sac are retracted from the margin and the muscular sphincter is retracted into the sub-cuticular parenchyma, and a wavy duct with wrinkled walls passes to the exterior to open at the anterior border of the lateral margin (figs. 23 & 24).

Female Reproductive Organs.

There is a large receptaculum seminis as in *C. lagorchestis*, and lying dorsal and to the inside of this are a number of tubules, arranged fan-wise, which collect into a circular sac, alongside of which, nearer the median field, is a small bean-shaped vitelline gland. The duct from the receptaculum seminis enters the circular sac of the ovary. The oviduct passes out dorsally, and passes through the shell-gland near its origin from the ovary and enters the uterus dorsal to the ovarian tubules. The vagina is a thick-walled duct much as in *C. lagorchestis*, but is not abortive. It does not open into a genital atrium but opens separately in the middle of the projecting lateral margin of the segment (figs. 23 & 24). The uterus arises as a single transverse duct and has proximal and distal diverticula. It passes above the female genitalia on each side to run out over the longitudinal canals into the lateral margins as in *C. pectinata* Goeze (fig. 27). The egg has a pyriform apparatus, the horns of which are filamentous and cross one another (fig. 29).

The characters which show that this species is in distinct contrast to other species are:—

(1) The extraordinary development of the fimbriations of the projecting sheath at the posterior border of each proglottis (fig. 16).

(2) The presence of two large testicular sacs instead of, as in other species, numerous small testicular sacs (figs. 30 & 31).

(3) The absence of reproductive organs entirely in some strobilæ (fig. 16).

(4) The absence of reproductive organs in the earlier proglottides (fig. 25).

(5) The male reproductive opening situated at the anterior edge of the projecting lateral margin and the female reproductive opening in centre of margin (figs. 23 & 24).

The species cannot be said to approach any of the described species closely, though possessing the general characteristics of the genus.

Of the works of reference the following list and also most of those given in the bibliography of (14) Johnston's "Entozoa of Monotremata and Australian Marsupials" were consulted.

For comparison of the above described species the following were found to be of most service:—7, 10, 11, 14, 15, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31.

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EXPLANATION OF THE PLATES.

Lettering.

C.=Cirrus.	Vit.Gl.=Vitelline gland.
C.P.=Cirrus-pouch.	Res.=Ovarian reservoir.
Ex.C.=Excretory canal.	L.Ex.=Longitudinal excretory canal.
G.A.=Genital atrium.	Ex.P.=Excretory pore.
F.G.P.=Female genital pore.	M.L.=Muscular layers.
M.G.P.=Male genital pore.	V.D.=Vas deferens.
Ut.=Uterus.	Ves.Sem.=Vesicula seminalis.
R.S.=Receptaculum seminis.	L.L.=Lateral lappet.
Vag.=Vagina.	Sk.=Suckers.
Sp.M.=Sphincter muscle.	V.Ex.=Ventral excretory canal.
Test.=Testes.	D.Ex.=Dorsal excretory canal.
S.T.=Spongy tissue.	N. or L.N.=Longitudinal nerve.
L.M.=Longitudinal muscle-layer.	Ov.=Ovary.
Ov.T.=Ovarian tubules.	F.Sh.=Fimbriated sheath.
T.Ex.=Transverse excretory canal.	C.M.=Circular muscle-layer.
Sh.Gl.=Shell-gland.	Ov.R.=Rudiments of female glands.

PLATE I.

Cittotenia lagorchestis.

Fig. 1. Portion of strobila showing lateral projections of segment margins. The two uteri distinct in the earlier segments and meeting in median field in older proglottides. Scolex with suckers, and no rostellum.

Fig. 2. Coronal section through head and first 25 segments, passing through suckers in head region.

3. Coronal section through middle of head between suckers showing origin of genital glands immediately behind head; first segments commencing immediately behind head. Large receptaculum seminis. Excretory ducts running up into head. Cirrus-pouch in some segments.

4. Transverse section of head across suckers.

PLATE II.

Cittotænia lagorchestis.

Fig. 5. Transverse section of very young proglottis showing vagina as a thick-walled duct below the cirrus-pouch.

6. Transverse section of an older proglottis showing vagina running out to open into genital atrium.

7. Coronal section of a number of ripe proglottides.

PLATE III.

Cittotænia lagorchestis.

Fig. 8. Transverse section showing transverse excretory canal connecting the larger ventral longitudinal canals.

9. Transverse section of proglottis, slightly older than in fig. 6, showing vagina which has lost its connection with the genital atrium and is becoming abortive.

10. Coronal section showing ovarian tubules arranged in a circle and opening by narrow ducts into reservoir.

PLATE IV.

Cittotænia lagorchestis.

Fig. 11. Enlargement of fig. 7, showing ovarian tubules, development of uterus, vitelline gland, shell-gland, testes, genital atrium, sphincter muscle, cirrus-pouch, cirrus, spongy tissue, receptaculum seminis, transverse and longitudinal excretory vessels, and longitudinal muscles.

12. Coronal section of a maturer portion of strobila showing uteri nearly meeting in median field. Disappearance of genital glands except cirrus-pouch and receptaculum seminis.

13. Coronal section of tail end showing reproductive organs to within twelve segments of posterior end.

PLATE V.

[*Cittotænia lagorchestis.*

Fig. 14. Coronal section same as fig. 12, showing protruded cirri.

15. Coronal section of posterior end showing excretory pore.

Cittotænia villosa.

16. Strobila showing fimbriations and liver-fluke shape.

PLATE VI.

Cittotænia lagorchestis.

Fig. 17. Longitudinal section in region of cirrus-sac showing testes and receptaculum seminis.

18. Transverse section of mature proglottis showing uteri nearly meeting in median field.

Cittotænia villosa.

19. Transverse section of head through suckers showing quadratic cross-section as contrasted with fig. 4.

20. Coronal section of head passing through suckers. Absence of neck and absence of reproductive organs; longitudinal excretory canals. Segmentation immediately behind head.

PLATE VII.

Cittotenia villosa.

- Fig. 21. Enlargement of head showing excretory canals running up into head suckers, and ornamented fimbriation.
22. Whole mount of a portion of strobila enlarged showing hair-like projections.
23. Coronal section showing male and female genital pores, uterus, cirrus, and vagina.

PLATE VIII.

Cittotenia villosa.

- Fig. 24. Coronal section showing uterus, vagina, cirrus-pouch, and cirrus.
25. Transverse section through young proglottis. Well-developed subcuticular musculature, absence of reproductive organs.
26. Transverse section showing protruded cirrus, sphincter muscle, cirrus-pouch, portion of vas deferens and of vesicula seminalis.

PLATE IX.

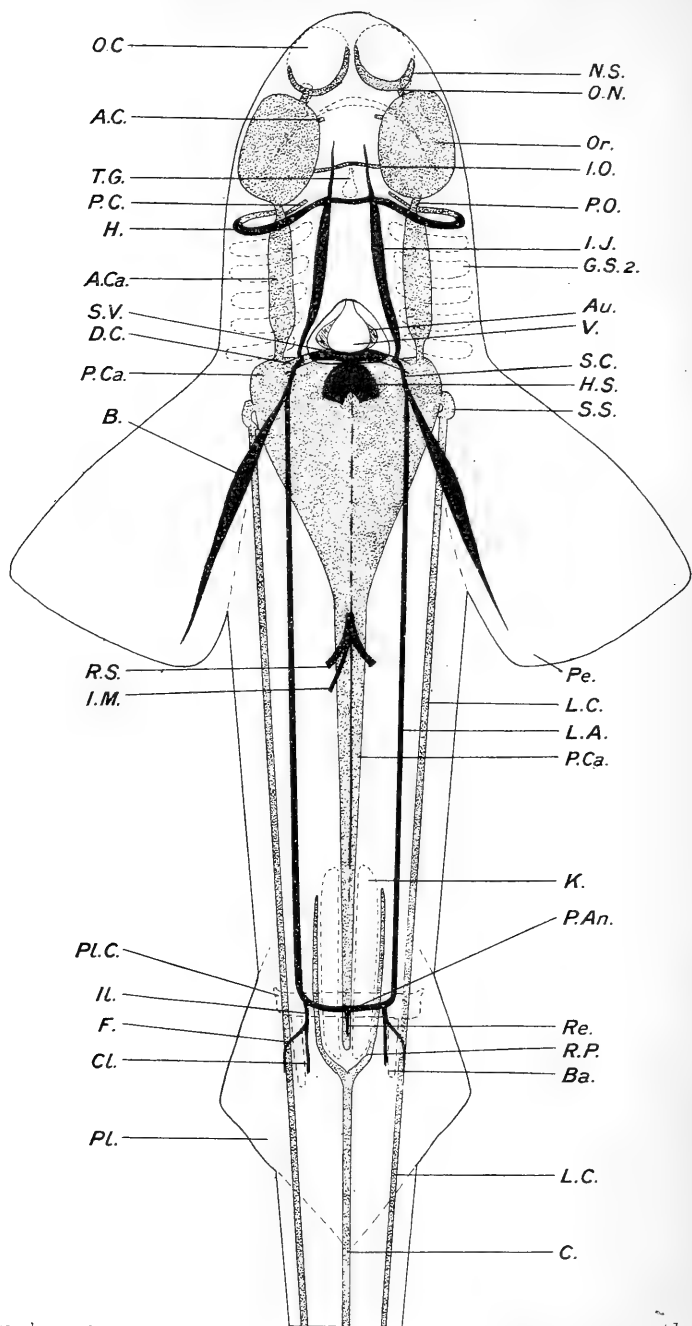
Cittotenia villosa.

- Fig. 27. Transverse section showing uterus in lateral margin.
28. Transverse section showing the two large receptacula seminis.
29. Egg with horns of pyriform body crossing.

PLATE X.

Cittotenia villosa.

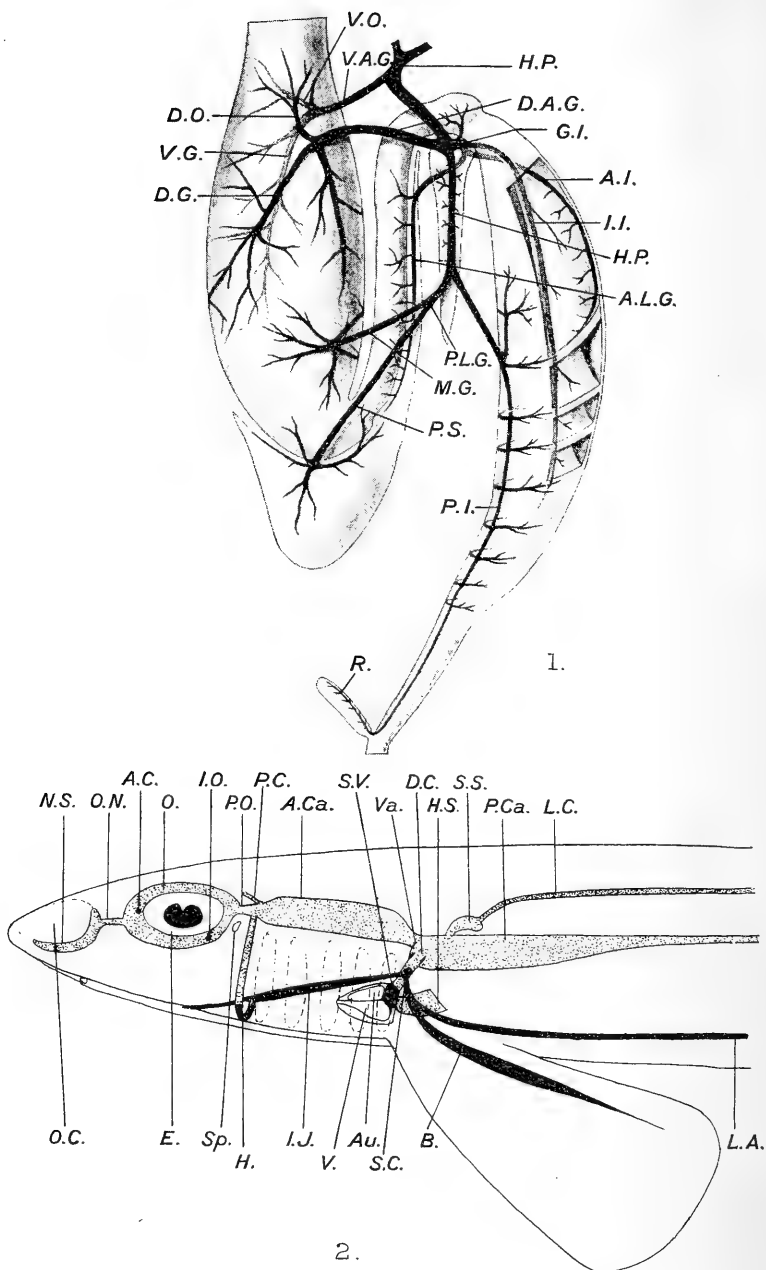
- Fig. 30. Enlarged transverse section showing testis sac, part of coiled vas deferens and of vesicula seminis, cirrus-pouch, and cirrus.
31. Same series as fig. 30, showing the connection of vas deferens with cirrus-pouch.



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VENOUS SYSTEM OF SCYLLIUM CANICULA.



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VENOUS SYSTEM OF SCYLLIUM CANICULA.

30. Notes on the Circulatory System of Elasmobranchs.
 I. The Venous System of the Dogfish (*Scyllium canicula*). By CHAS. H. O'DONOGHUE, D.Sc., F.Z.S.,
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(Plates I., II. * & Text-figures 1-4.)

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I. INTRODUCTION.

The foundation of our modern knowledge of the circulatory system of Elasmobranchs was laid by T. J. Parker in his work on the venous system of the skate (*Raja nasuta*, 9), and extended by his masterly description of the blood-vessels of *Mustelus antarcticus*, in 1886 (10). This latter provides a full account of the researches prior to that date, and also a full bibliography.

Since that date only two papers have dealt with the subject. Rand and Ulrich have discussed the posterior connections of the lateral vein in the skate in 1905 (14), and Diamare the splanchnic arteries and veins in *Scyllium catulus* and *Torpedo marmorata* (2).

Since Balfour's account (1) the general development of the venous system in Elasmobranchs has been referred to by a number of authors, including Hoffmann (5), Rabl (11 & 12), and Hochstetter (3 & 4), and the development of the head veins by Grosser (2 a), so that it is only necessary here to refer quite briefly to the stage in a late embryo so as to indicate the order in which the veins in the adult are described.

Although many dogfish have been dissected, there is no complete account of the venous system. The descriptions given in the text-books for the most part appear to be based upon T. J. Parker's work already referred to, and are not altogether

* For explanation of the Plates see pp. 454, 455.

satisfactory. Although the general disposition of the main vessels in *Mustelus antarcticus* is somewhat similar to that in *Scyllium canicula*, the two species differ considerably in detail in the veins and, as might be expected from the modification of form undergone by the skates, the veins of these are markedly different from those in the dogfish. In view of this and of the fact that *Scyllium* is frequently used as a type in the laboratory, the venous system of the latter appears worthy of description.

An account of the arteries, on the other hand, is not so necessary, as they do not vary nearly so markedly from those described in other Elasmobranchs as do the veins and, moreover, they are much more satisfactorily dealt with in text-books.

The animals were investigated by means of injection and series of transverse sections through embryos of 37 and 56 mm. length, and serial sections through a frozen adult were also examined in order to check certain points. The injection-fluids used were the gelatine mass, recommended by Tandler (15) for the finer details, and the starch mass advised by Kingsley (6) for the larger vessels. In a previous communication on the blood-vessels of the grass-snake (7) I recommended using a mixture of the solid matter that settles to the bottom of the starch mixture with about twice its volume of gelatine, and I have now found that an almost identical mixture was suggested for the blood-vessels of the skate some time previously by Rand (13).

Perhaps the most striking feature of the venous system of *Scyllium* is the dilatation of the vessels to form sinuses. These sinuses render the injection of the system as a whole impractical, and the indefinite nature of their walls makes it extremely difficult to trace their exact course and extent with certainty or to locate the points of entry of the smaller tributaries.

For the sake of ready reference the names of the vessels adopted by Parker have been used as far as possible, and wherever alteration has been made Parker's terminology is also given.

II. DEVELOPMENT.

The pre-cardiac part of the venous system at a fairly late stage of development is represented by the anterior cardinal vein. This is morphologically composed of two sections: from the ear back to the ductus Cuvieri it is the persistent anterior cardinal, but the front part of this vessel has been replaced by the lateral cephalic vein. It is convenient, however, to speak of the whole trunk in the adult as the anterior cardinal sinus. In the adult an inferior jugular vein is developed on each side in addition to the foregoing sinus.

In the post-cardiac portion two distinct systems are to be recognised: first, the posterior cardinal veins, and second, the sub-intestinal vein. The posterior end of the first forms a loop around the growing mesonephroi, and later the median portions of the two loops fuse to constitute the inter-renal section of the

definitive posterior cardinal sinuses. The second divides into two parts—an anterior which gives rise to the hepatic portal vein, and a posterior which acquires a connection with the outer side of the kidney loop and forms the renal-portal vein.

Text-figure 1

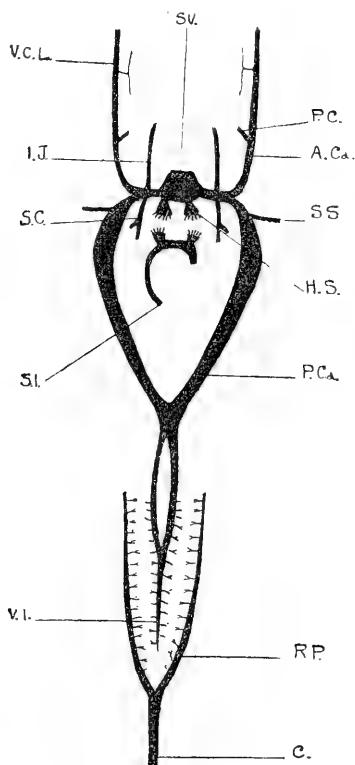


Diagram of the vessels in a fairly late embryo of *Scyllium canicula*.

V.C.L. Vena capitis lateralis. S.I. Sub-intestinal vein. V.I. Inter-renal vein.

For explanation of other lettering see p. 454.

Adopted and modified from Rabl (11).

According to Rabl (11), quoted also by Hochstetter (4), the sub-clavian vein is described and figured as opening into the posterior cardinal sinus, whereas in *Scyllium*, in *Mustelus*, and in the skates, this vein opens into the ductus Cuvieri, and in the two former it opens into the ductus between the point of entry of the anterior cardinal sinus and the sinus

venosus. In the adult *Scyllium* and *Mustelus* the vessel opening into the posterior cardinal vein in the position of that described by Rabl as the "sub-clavian" is really the sub-scapular.

In an embryo of 56 mm. it is quite easy to trace the relations of these two vessels, which are found to be the same as in the adult. The sub-clavian vein, formed by the union of the brachial and lateral abdominal veins, opens into the sinus venosus on its ventral side nearer the middle line than the opening of the anterior cardinal sinus. The sub-scapular vein, into which the lateral cutaneous vein opens, joins the posterior cardinal vein in about the position indicated by the "sub-clavian" vein of Rabl.

A sub-clavian vein is figured by Grosser (2 a, p. 184, fig. 4) in the same position in an embryo of only 26 mm., although its relation to the brachial and lateral abdominal veins is not shown, nor is it identified as sub-clavian.

Rabl himself says (11, p. 233): "In den proximalen Theil des Cardinalvenensinus mündet die Vena subclavia ein. Ausserdem tritt in die untere Wand des Ductus Cuvieri eine Vene, die nach hinten bis zu den Bauchflossen zu verfolgen ist, und deren Lage unter der Musculatur der vorderen Bauchwand es nicht zweifelhafterscheinen lässt, dass man es hier mit der Parietal-oder Seitenvene zu thun hat. Auf diese Vene habe ich im Schema keine Rücksicht genommen."

It will be seen, then, that Rabl recognises two veins, but I venture to think that he has misinterpreted one of them and in calling it the sub-clavian vein has suggested a connection with the pectoral fin which does not exist. A muddle, probably resulting from this, is to be found in nearly all the text-book descriptions of *Scyllium*, in which it is stated that the sub-clavian vein enters the lateral border of the front end of the posterior cardinal sinus and brings back blood from the pectoral fin. In all Elasmobranchs described, and also in *Scyllium*, the blood is returned from the pectoral fins by the brachial veins. These open into the lateral abdominal veins, and the common trunks so formed, which may be justly termed sub-clavian veins, open into the ductus Cuvieri.

For descriptive purposes it is easy to divide the venous system according to its derivation from the embryonic condition just described into pre-cardiac vessels, post-cardinal vessels, and sub-intestinal vessels, to which must be added the lateral veins, the coronary veins, and the cutaneous veins.

III. THE PRE-CARDIAC VESSELS.

1. *The Orbital Sinus.*

1. i. The Nasal Sinus.
1. ii. The Orbito-Nasal Vein.
1. iii. The Anterior Cerebral Vein.
1. iv. The Inter-Orbital Vein.

2. *The Post-Orbital Sinus.*3. *The Anterior Cardinal Sinus.*

- 3. i. The Hyoidean Sinus.
- 3. ii. The Posterior Cerebral Vein.
- 3. iii. The Myelonal Veins.
- 3. iv. The Nutrient Branchial Veins.

4. *The Inferior Jugular Sinus.*

1. *The Orbital Sinus* (Parker) [Pl. I., Or.] is a large irregular sinus occupying the whole of the cavity of the orbit not occupied by the eyeball and its muscles. It is easily recognised as a blood sinus, for it almost always contains a considerable amount of clotted blood in the freshly-killed animal and even in preserved specimens.

It receives, in addition to the orbito-nasal vein, the anterior cerebral vein, which enters it on its lateral wall a little way behind the point of origin of the inferior oblique muscle. The two orbital sinuses communicate with one another by means of an inter-orbital vein.

1. i. *The Nasal Sinus* [Pls. I. & II., N.S.] is a well-marked crescent-shaped sinus situated somewhat ventrally on the inner and hinder margins of the olfactory sac. The two sinuses, although approximating very closely in the middle line, are completely separated by the cartilaginous inter-nasal septum. They collect the blood from the snout and olfactory sacs by a number of more or less indefinite trunks, some of which come from the anterior end of the roof of the mouth. They are figured in an embryo of 26 mm. by Grosser (2 a, fig. 4).

1. ii. *The Orbito-Nasal Vein* [Pls. I. & II., O.N.] is a small but distinct vein passing through a canal in the cartilage separating the olfactory sac from the orbit and entering the latter at its lower, inner, anterior corner by a well-marked orbito-nasal foramen. It conveys the blood from the nasal to the orbital sinus.

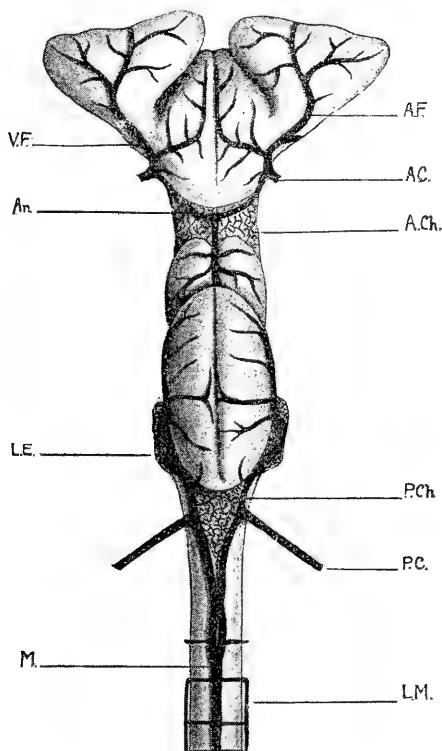
This vein appears to correspond to the anterior facial vein of Parker, who states that in *Mustelus antarcticus* he was unable to get a satisfactory injection of it. In *Scyllium* it is fairly easy to inject with gelatine mass from the orbital sinus by means of a pancreatic canula which will jam into the orbito-nasal foramen.

1. iii. *The Anterior Cerebral Vein* (Parker) [Text-fig. 2, A.C.] is formed by the union of three factors at the posterior dorso-lateral border of the diencephalon, whence it passes directly outwards through a foramen in the cranial wall and empties itself into the orbital sinus. The anterior factor is itself composed of two smaller tributaries, one of which starts on the ventral surface of the olfactory lobe and passes forwards and then upwards to the dorsal surface. Here it runs backwards to

the main trunk, just before joining which it receives the other tributary coming from the prosencephalon.

The ventral factor collects blood from the lower surface of the prosencephalon and diencephalon as far back as the optic chiasma and passes dorsally into the main vein. The third factor is a posterior one that passes behind the edge of the prosencephalon to anastomose with its fellow. In the middle line this vessel receives a vein from the optic lobes and a large number of smaller ones from the anterior choroid plexus roofing the third ventricle.

Text-figure 2.



Sketch of the dorsal side of the brain of *Scyllium canicula*, showing the arrangement of the anterior and posterior cerebral veins.

For explanation of lettering see p. 454.

1. iv. *The Inter-Orbital Vein* [Pls. I & II., I.O.] is a small but well-marked vein running from one orbit to the other in a canal in the basi-cranial cartilage, and it enters the orbit towards its posterior end just in front of and slightly below the large

foramen through which the sixth and main branches of the fifth and seventh cranial nerves leave the cranium. It is situated directly under a well-marked ridge in the floor of the cranial cavity immediately behind the pituitary body.

2. *The Post-Orbital Sinus* [Pls. I. & II., P.O.] is a moderate-sized vessel placing the orbital sinus in communication with the anterior cardinal sinus. It passes backwards from the posterior external part of the orbit around the auditory capsule dorsally to the spiracle. Its path around the capsule is indicated by a well-marked groove, the post-orbital groove, which is to be found between the ridge formed by the horizontal semi-circular canal and the smooth surface for the articulation of the hyomandibular cartilage.

3. *The Anterior Cardinal Sinus** (Jugular Vein, Parker) [Pls. I. & II., A.C.] is a very large and irregular sinus running along the internal dorsal ends of the gill-clefts. It starts close behind the spiracle at the anterior end of the first gill-cleft and runs to a point a short way behind the fifth gill-cleft. At its front end it receives the post-orbital sinus. The two anterior cardinal sinuses are situated at about the same depth below the dorsal surface of the animal as the vertebral column, with which they are approximately parallel. The pharyngeal-branchial cartilages project into the floor of the sinuses, forming well-marked ridges which possess membranous flaps. The sinuses are readily exposed from the dorsal side of the fish when making a dissection of the cranial nerves, and, indeed, the branchial branches of the tenth cranial nerves pass freely through their cavities, while the visceral branches of the same are partially embedded in their mesial walls. Just behind the fifth gill-cleft the anterior cardinal sinus narrows down considerably, and passing ventrally opens into the posterior cardinal sinus by an opening provided with a valve (*vide* footnote, p. 444).

The anterior cardinal sinus receives small tributaries from the dorsal ends of the gill-bars and from the surrounding musculature, but their position is extremely difficult to ascertain owing to the indefiniteness and irregularity of the walls of the sinus. At its front end the anterior cardinal sinus receives the posterior cerebral vein and the hyoidean sinus.

3. i. *The Hyoidean Sinus* (Parker) [Pls. I. & II., H.] is a moderate-sized vessel situated in front of the first gill-cleft and running parallel with it from the dorsal to the ventral side of the fish. It lies in a shallow groove on the external side of the hyomandibular cartilage, and at its dorsal end enters the anterior cardinal sinus near the point where the latter receives the post-orbital sinus. The ventral end joins the inferior jugular sinus at the level of the posterior end of the thyroid gland.

The hyoidean sinus doubtless receives the blood from the tissues surrounding it, but it is extremely difficult to make out

* This name is used because, as Parker points out, the vein is not in any way homologous with the jugular vein of higher animals.

any definite tributaries corresponding to the nutrient branchial veins and the posterior facial vein described by Parker in *Mustelus*.

3. ii. *The Posterior Cerebral Vein** (Parker) [Text-fig. 2, P.C.] commences at the anterior end of the cerebellum and passes backwards along its side. Towards the posterior end of the cerebellum, after receiving a well-marked tributary coming from its mid-dorsal region, it runs out laterally over the sac-like lateral dilatation of the posterior choroid plexus. Here it drains a remarkable venous network, a kind of rete mirabile, composed of quite well-marked veins. Its path now lies along the lateral border of the median portion of the posterior choroid plexus, from which it receives numerous tributaries, and just before the calamus scriptorius it passes out through the cranium closely apposed to the dorsal surface of the tenth cranial nerve. It parts company with this nerve outside the cranium and apparently passes through the muscles to the front end of the anterior cardinal sinus, but it is difficult to follow. The fine veins from the membranous labyrinth appear to open into the posterior cerebral vein at its inner end. Parker describes and figures the veins not as passing through the cranial wall but as running backwards to unite and form the myelonal vein.

Grosser has figured this vein in an embryo of *Scyllium* 26 mm. long (2 a, fig. 4), but does not call attention to it in the text. In dealing with *Triton* and *Salamandrina*, however, he mentions this vein as leaving the skull with the vagus nerve, and points out that it is of general occurrence in many of the higher groups, a fact also noted by Gaupp. It was readily made out in the sections of embryos of 37 and 56 mm. length that were examined.

3. iii. *The Myelonal Veins* (Parker) [Text-fig. 2, M.]. Two well-marked myelonal veins are present, a dorsal and a ventral.

The dorsal myelonal vein runs the length of the spinal cord, and at the anterior end forks just behind the calamus scriptorius. The two limbs of the fork run into the posterior cerebral vein just as it is leaving the cranial cavity. Parker describes this vessel as forming a rhomboidal plexus in each vertebral segment, but although the anterior end of the vein may be more or less double for a short way behind the point where it divides, there is no sign of this arrangement in *Scyllium*. Segmental veins are given off, and these often tend to form a lateral vessel on each side of the cord by anastomosing in a longitudinal direction; it appears to be very irregular, however.

The ventral myelonal vein is formed by the union of two

* This vein and the anterior cerebral are very difficult to inject, as it is almost impossible to insert even a hypodermic needle into them. However, I found that they could be made distinct in the following way. After the anterior cardinal vessels of a freshly killed fish have been quite filled with injection mass and plugged, the cranium is dissected away so as to expose as much of the brain as possible. A fixing fluid, corrosive formol, is slowly injected into the dorsal aorta until the cranial arteries begin to get colourless and the veins distended with blood. If the anterior end of the fish in this condition is placed in 5 per cent. formalin overnight, it will be found that the blood in the veins has coagulated and become dark in colour.

branches. Each commences by the side of the lobi inferiores just behind the optic chiasma and passes backwards, draining the saccus vasculosus, to unite behind the pituitary body to form a median vessel. This runs the length of the spinal cord, giving off small segmental branches.

3. iv. *The Nutrient Branchial Veins* (Parker) are a series of four indistinct vessels on each side which bring back the blood from the four holobranchs. Their anatomical relations do not appear to be so constant and cannot be made out so definitely as in *Mustelus*.

4. *The Inferior Jugular Sinus* (Parker) [Pls. I. & II., I.J.] is a moderate-sized, indefinite vessel situated below the floor of the mouth. It commences as a small vein shortly behind the symphysis of the lower jaw and passes backwards to the level of the hinder end of the thyroid gland, where it receives the hyoidean sinus and also anastomoses with its fellow. This anterior segment may perhaps correspond with the mandibular vein described by Parker. The anastomosis between the two inferior jugulars takes the form of an extremely irregular trunk passing along the base of the thyroid gland (around which blood-clots are frequently to be found) and bathing the innominate arteries. From this point the jugular sinus widens out considerably and runs along the internal sides of the ventral ends of the gill-clefts, bathing the proximal parts of the afferent branchial arteries, back to the wall of the pericardium. Here it narrows and passes along the wall to open into the proximal part of the ductus Cuvieri by an opening common to it and the sub-clavian vein.

IV. THE POST-CARDINAL VESSELS.

The Posterior Cardinal Sinus.

1. *The Renal Veins.*

2. *The Genital Sinus.*

A. The Ovarian Sinus.

B. The Spermatic Vein.

2. i. The Intestino-Mesenteric Vein.

3. *The Anterior Parietal Veins.*

4. *The Anterior Oviducal Sinus.*

5. *The Sub-scapular Sinus.*

6. *The Spinal and Œsophageal Veins.*

The Posterior Cardinal Sinus (Parker) [Pls. I. & II., P.Ca.] originates between the kidneys, where the two posterior cardinal sinuses are united to form a median vessel. At the anterior end of the kidneys the right and left sinuses are usually separated by a partition passing from the dorsal to the ventral wall in the

middle line. Each cardinal sinus runs forwards as a fairly narrow vessel to a point just in front of the anterior mesenteric artery and then commences to widen out. At the anterior end the two sinuses occupy the whole of the region dorsal to the œsophagus right up to the pericardio-peritoneal septum and outwards to the sides of the body. The condition of the septum between the sinuses at the front end varies greatly in different specimens. It may be practically absent, represented only by a few strands, it may be well developed with perforations, or most frequently it is in a condition between these two extremes. The posterior cardinal receives the renal veins, the genital sinus, the anterior parietal veins, the anterior oviducal sinus in the female, the sub-scapular sinus, the veins from the spinal cord, and at its front end the anterior cardinal sinus and the ductus Cuvieri open into it*.

The Renal Veins (Parker) are represented by a series of efferent vessels leaving the kidneys. They do not appear as separate vessels outside that organ, as the wall of the posterior cardinal sinus is in contact with the mesial border of the kidney.

2. *The Genital Sinuses* differ in the two sexes and will be dealt with separately.

A. *The Ovarian Sinus* is a large trunk composed of numerous irregular factors and runs in the mesovarium dorsal to the ovary from its posterior end. A very similar but smaller vein is formed at the anterior end of the ovary, and the two unite in the first third of that body and pass dorsally into the posterior cardinal sinus in the region where the anterior mesenteric and lienogastric arteries are given off from the dorsal aorta. Just before entering the posterior cardinal sinus it swells out somewhat and receives the intestino-mesenteric vein.

B. *The Spermatic Vein* (Parker) [Pl. I., R.S.] is subject to a considerable amount of variation, and often each testis possesses two separate veins. The posterior drains the hinder two-thirds of the testis and, passing dorsally through the mesorchium, joins its fellow of the opposite side to form a common genital sinus which opens into the posterior cardinal sinus. The intestino-mesenteric vein often joins the right spermatic vein just before it unites with the left. The anterior spermatic vein drains the front portion of the testis, in front of which it joins with its fellow and opens into the posterior cardinal sinus. Sometimes, perhaps more generally, this anterior spermatic vein is simply a factor of the posterior one, which is always the main vein.

* It is stated that developmentally the anterior and posterior cardinal veins open separately on the anterior and posterior sides of the ductus Cuvieri respectively. That this description, given by Hoffmann (5), Hochstetter (3), Balfour (1), and others, is the correct one can easily be verified by reference to a series of sections of an embryo of *S. canicula*. In the adult, however, the actual anatomical relations are different, possibly because of the dilatation of the veins to form sinuses, and we find that the anterior cardinal sinus opens into the posterior cardinal sinus by an aperture guarded by a valve, and the ductus Cuvieri projects as a short tube into the posterior cardinal sinus, opening therein by an oval aperture.

2. i. *The Intestino-Mesenteric Vein* [Pl. I., I.M.] is a small but nevertheless well-marked vessel that collects the blood from the right side of the intestine in the region of the spiral valve and runs through the mesentery, from which it receives branches, to open into the genital sinus. In the male it flows into the branch from the right testis shortly before this joins with its fellow in the middle line.

3. *The Anterior Parietal Veins* (ant. spinal veins, Parker) come from the myotomes of the body between the pericardio-peritoneal septum and the anterior end of the kidney and flow into the posterior cardinal sinus.

4. *The Anterior Oviducal Sinus* (ant. ov. vein, Parker) is a large vessel situated around the oviduct in the region of the oviducal gland in the full-grown female. It is a very large sinus, quite separate from the posterior cardinal sinus into which it opens at its anterior end. In the immature female this sinus cannot be detected, but in the adult, and more especially when the oviducal gland appears to be active, it is obvious enough.

5. *The Sub-Scapular Sinus* [Pls. I. & II., S.S.] is a small sinus situated on the dorso-lateral aspect of the dogfish immediately behind the fifth gill-cleft and just ventral to the dorsal end of the scapular cartilage. It joins the posterior cardinal sinus on its dorso-lateral edge towards the anterior end by one or two small openings guarded by a valve. Into it opens the lateral cutaneous vein. As is pointed out above this vessel is generally but incorrectly termed the sub-clavian vein.

6. *The Spinal and Œsophageal Veins.* The veins from the spinal cord in the body region flow into the posterior cardinal sinus. A few small veins from the extreme front end of the Œsophagus may also enter this sinus, but the main part of the blood from the Œsophagus is collected by a factor of the hepatic portal system.

V. THE LATERAL VEINS.

The Sub-Clavian Vein.

1. *The Lateral Abdominal Vein.*

2. *The Iliac Vein.*

1. i. *The Femoral Vein.*

2. ii. *The Cloacal Vein.*

3. *The Rectal Vein.*

4. *The Brachial Sinus.*

The Sub-Clavian Vein [Pls. I. & II., S.C.]. The condition of this vein in the embryo has already been noted. In the adult it is a short trunk passing from the union of the lateral abdominal vein and brachial sinus dorsally along the edge of the coracoid cartilage, and it flows into the ductus Cuvieri through a common opening with the inferior jugular sinus. Its position justifies it

being termed the sub-clavian vein and, in addition, it is homologous with the similarly named vein in *Rana* *.

1. *The Lateral Abdominal Vein* (Lateral Vein, Parker) [Pls. I. & II., L.A.] is a moderate-sized vessel that runs immediately beneath the peritoneum along the ventro-lateral wall of the body-cavity. It originates as a continuation of the iliac vein on the dorsal side of the pelvic cartilage, across which it anastomoses with its fellow of the other side. Thence it passes forwards in the body-wall to the pericardio-peritoneal septum, in the wall of which it turns very sharply dorsalwards and slightly mesially along the posterior edge of the coracoid cartilage. A short distance along this it unites with the brachial sinus to form the sub-clavian vein.

2. *The Iliac Vein* (Parker) [Pl. I., II.] is a short vessel formed by the union of the femoral and cloacal veins on the inner side of the basipterygium towards its anterior end. It runs into the lateral abdominal vein on the dorsal surface of the pelvic bar.

2. i. *The Femoral Vein* (Parker) [Pl. I., F.] drains the major part of the pelvic fin and is situated laterally and slightly dorsal to the basipterygium. It passes across the anterior end of this cartilage, which is slightly notched to receive it, to unite with the cloacal vein.

2. ii. *The Cloacal Vein* (Parker) [Pl. I., Cl.] lies on the inner side of the basipterygium, and is formed by the union of factors from the posterior and lateral walls of the cloaca and also from the inner side of the pelvic fin.

It will be noted that the arrangement of the factors of this vein agree more nearly with those described by Parker in *Mustelus* than with those figured by the same author for *Raja nasuta*, and those in *R. erinacea* and *R. lævis* according to Rand and Ulrich (14). The additional factors in the skates are doubtless to be correlated with the greater relative size of the pelvic fin. A similar difference is found in the brachial veins; only one such is present on each side in *Scyllium*, while two are found in *R. erinacea* and *R. lævis* and three in *R. nasuta*.

Further similarity with *Mustelus* is shown by the presence of a pelvic anastomosis between the lateral abdominal veins in *Scyllium* but not in the skates.

3. *The Rectal Vein* [Pl. I., Re.] is a small short vessel joining the anastomosis between the lateral abdominal veins in the middle line. Its branches form a fairly rich network of vessels spread over about the last one and a half inches of the rectum and the body-wall ventral to this.

This vessel is not represented in *Mustelus*, where the posterior end of the rectum is drained by a fairly large proximal tributary of the cloacal vein on each side. It more nearly resembles the

* In the tadpole the sub-clavian vein is formed by the union of the musculo-cutaneous, brachial, and the epigastric veins, the latter being homologous with the lateral abdominal veins. In the adult the two epigastrics are reduced to a median vein, the anterior abdominal, which acquires a secondary connection with the hepatic portal vein, though in certain abnormal specimens the primitive connection is retained (8).

condition in *R. erinacea* and *R. laevis*, where paired vessels from the end of the rectum run straight into the lateral abdominal veins.

4. *The Brachial Sinus* (Br. vein, Parker) [Pls. I. & II., B.] collects blood from the pectoral fin and passes along near its posterior edge. It leaves the fin and penetrates the body-muscles to open into the lateral abdominal vein on the posterior edge of the coracoid cartilage.

The Cutaneous Veins.

1. *The Lateral Cutaneous Vein.*

2. *The Posterior Ventral Cutaneous Vein.*

1. *The Lateral Cutaneous Vein* (Parker) [Pls. I. & II., L.C.] originates far back in the tail, and forms a well-marked vessel running to the region of the pectoral fin, in the connective tissue immediately underlying the lateral-line canal. Here it passes inwards and opens into the sub-scapular sinus. Parker describes anastomoses between it and the caudal vein, and such anastomoses can be found in sections of embryos of 56 mm., but I have been unable to inject and display them by ordinary dissection.

2. *The Posterior Ventral Cutaneous Vein* (Parker) can be seen in transverse sections both of embryos and of adult fish. It runs forward embedded in the connective tissue in the mid-ventral line from the tail, forms a loop around the anal fin, and forks in the region of the cloaca. A similar vein is to be found under the cutis in the median line of the abdomen, and this doubtless corresponds to the anterior ventral cutaneous vein of Parker, but the exact relations of its anterior and posterior ends could not be ascertained as it is too small for injection.

Serial sections through embryos of 37 and 56 mm. length have been studied, and the general arrangement of these cutaneous vessels is apparently similar to that in *Mustelus* as described by Parker. They are not dealt with in detail here as they have only been followed in the above sections, and they cannot be studied in the adult by ordinary methods of injection.

The ventral cutaneous veins are too small to inject successfully, even with a hypodermic syringe, and the dorsal cutaneous vein is barely visible to the naked eye.

VI. THE SUB-INTESTINAL VESSELS.

A. The Hepatic Portal Vein.

1. *The Posterior Intestinal Vein.*

2. *The Posterior Lieno-gastric Vein.*

2. i. The Posterior Splenic Vein.

2. ii. The Median Gastric Vein.

3. *The Pancreatic Veins.*

4. *The Gastro-intestinal Vein.*
 4. i. The Intra-intestinal Vein.
 4. ii. The Anterior Intestinal Vein.
 4. iii. The Anterior Lieno-gastric Vein.
5. *The Dorsal Anterior Gastric Vein.*
 5. i. The Dorsal Gastric Vein.
 5. ii. The Dorsal Œsophageal Vein.
6. *The Ventral Anterior Gastric Vein.*
 6. i. The Ventral Gastric Vein.
 6. ii. The Ventral Œsophageal Vein.
7. *The Hepatic Veins and Sinuses.*

B. The Renal Portal Veins.

1. *The Caudal Vein.*
2. *The Renal Portal Vein.*
 2. i. The Posterior Oviducal Veins.
 2. ii. The Posterior Parietal Veins.

THE HEPATIC PORTAL SYSTEM.

The hepatic portal system consists of a number of large well-marked veins, mostly lying in the gut mesenteries, which convey blood from the whole of the alimentary canal (from œsophagus to rectal gland inclusive) to the liver. In the higher vertebrates all the blood collected from the gut is taken to the liver, but in *Scyllium* there is an exception to this general rule in the presence of an intestino-mesenteric vein. There are marked differences between the component veins of this system in *Mustelus antarcticus*, according to Parker, and in *Scyllium*, and in consequence the nomenclature here adopted is descriptive and does not necessarily imply homology. The system may be conveniently and easily injected from the main trunk near the liver.

A. *The Hepatic Portal Vein* [Pl. II., H.P.] is formed in the pancreas, a short distance from its posterior end, by the confluence of the posterior intestinal and posterior lieno-gastric veins. It runs partially embedded in the right dorsal edge of the pancreas to the anterior end of that body, and receives during this part of its course a number of small tributaries, the pancreatic veins. At the anterior end of the pancreas it is joined by two large veins; one, the dorsal anterior gastric, enters it on the right, and the other, the gastro-intestinal, enters it somewhat ventrally on the left. From this point it runs for a short distance, about 1.5 cm., in the gastro-hepatic omentum before it receives its last large tributary, the ventral anterior gastric vein. It is now an extremely large vein with a diameter, when fully distended, of

about 5 mm., and it quickly divides into two main branches, a right and a left, one feeding each lobe of the liver.

Text-figure 3.

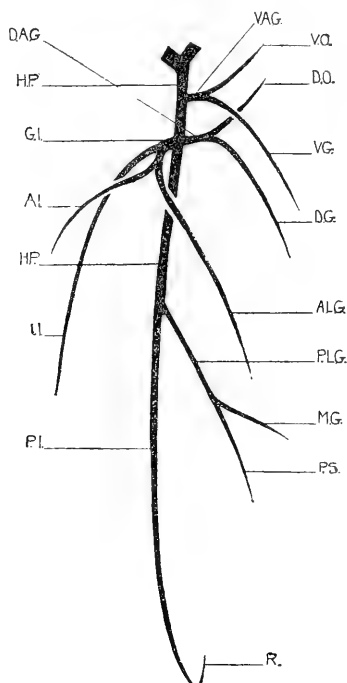


Diagram of the factors of the Hepatic Portal System in *Scyllium canicula*, viewed from the ventral side.

For explanation of lettering see p. 454.

1. *The Posterior Intestinal Vein* [Pl. II., P.I.] commences as a small vein on the ventral side of the rectal gland, and then, turning sharply upon itself, passes along the dorsi-lateral wall of the intestine to a point just posterior to the caudal end of the pancreas. At this place, marked also as the point at which the anterior mesenteric artery reaches the gut-wall, the posterior intestinal vein receives a fairly large factor from the anterior end of the intestine, and then it runs freely to join the posterior lieno-gastric vein in the pancreas. During its course along the intestine the vein receives a number (usually eight) of well-marked paired tributaries, whose position on the outside of the intestine marks the line of insertion of the folds of the spiral valve within.

2. *The Posterior Lienogastric Vein* [Pl. II., P.L.G.] is formed dorsally to the gut by the union of the posterior splenic and posterior gastric veins, and it runs from this junction to the posterior end of the pancreas and along the right dorsal edge of this gland, until it unites with the posterior intestinal vein to give rise to the hepatic portal vein.

2. i. *The Posterior Splenic Vein* [Pl. II., P.S.] is fairly large and situated dorsally to the posterior end of the cardiac division of the stomach. It collects blood from the posterior portion of the spleen, and it receives in addition one or two small branches from the stomach.

2. ii. *The Median Gastric Vein* [Pl. II., M.G.] is also fairly large, and it is formed by the union of several branches from the posterior dorsal region of the cardiac division of the stomach. It leaves the stomach-wall at the point where the lienogastric artery joins it, and it runs by the side of this artery until it unites with the posterior splenic vein.

3. *The Pancreatic Veins* are a number of small tributaries that flow into the hepatic-portal vein in its course along the edge of the pancreas.

4. *The Gastro-Intestinal Vein* [Pl. II., G.I.] is a short vein, hidden away in the fold between the pylorus and intestine, which commences about the middle of the anterior edge of the pancreas and runs along this edge into the hepatic-portal vein. It is formed by the union of the intra-intestinal, the anterior lienogastric, and anterior intestinal veins, and in addition receives one or two branches from the pyloric thickening.

4. i. *The Intra-Intestinal Vein* [Pl. II., I.I.] is a large vein bringing back the blood from the spiral valve. The valve is extremely well supplied with large capillaries, and numerous branches in each fold feed the intra-intestinal vein which runs in the central core of the spiral valve. It perforates the wall of the intestine at the anterior end of the spiral valve close against the pyloric valve, and it emerges from the intestinal wall in the sharp bend between the intestine and the pyloric thickening, where it quickly unites with the anterior intestinal and anterior lienogastric veins.

4. ii. *The Anterior Intestinal Vein* [Pl. II., A.I.] is of moderate size, and originates in the line of insertion of the first fold of the spiral valve in the intestine towards the dorsal side of the latter. It follows the valve round and comes through the intestinal wall on its ventral side close to the anterior lobe of the pancreas. Here it receives one or two branches from the wall of the ventral part of the anterior end of the intestine and runs straight to the pancreas, where it unites with the anterior lienogastric vein.

4. iii. *The Anterior Lienogastric Vein* [Pl. II., A.L.G.] is situated between the anterior lobe of the spleen and the pyloric division of the stomach, and receives tributaries from both these bodies. It arises near the level of the division between the two parts of the stomach and runs to the beginning of the bend

between the intestine and the stomach, where it branches off to the anterior lobe of the pancreas.

5. *The Dorsal Anterior Gastric Vein* [Pl. II., D.A.G.] is formed by the union of the dorsal gastric and dorsal œsophageal veins, and runs in the mesentery from the dorsal anterior side of the stomach into the hepatic-portal vein just as the latter is leaving the front dorsal end of the pancreas.

Diamare (2) describes and figures a fairly large anastomosis between the dorsal anterior gastric vein (*vena gastrica dorsalis anterior*) and the median gastric vein (*vena gastrica media*) in *Scyllium catulus*. I have examined eight specially injected specimens of *S. canicula* and numerous fresh ones, but have been unable to find this anastomosis. A large branch runs forwards to join the dorsal anterior gastric vein, and a smaller one originating near it runs backwards into the median gastric vein (*vide* fig. 1, Pl. II., P), but the two do not anastomose by any well-marked vessel such as Diamare figures, although they are indirectly in communication by means of capillaries.

5. i. *The Dorsal Gastric Vein* [Pl. II., D.G.] is a well-marked vein composed of two main tributaries, which collect the blood from the right and left sides of the anterior two-thirds of the cardiac division of the stomach.

5. ii. *The Dorsal Œsophageal Vein* [Pl. II., D.O.] brings back blood from the dorsal side of the œsophagus.

6. *The Ventral Anterior Gastric Vein* [Pl. II., V.A.G.] is a large trunk receiving one branch from the stomach, the ventral gastric vein, and one branch from the œsophagus, the ventral œsophageal vein. It leaves the stomach-wall on its ventral side, anterior to the point of departure of the dorsal anterior gastric vein, and it runs in the mesentery to flow into the hepatic-portal vein shortly before the latter divides into its right and left branches.

6. i. *The Ventral Gastric Vein* [Pl. II., V.G.] is a conspicuous vessel formed by the confluence of a number of tributaries from the ventral side of the anterior two-thirds of the cardiac division of the stomach.

6. ii. *The Ventral Œsophageal Vein* [Pl. II., V.O.] collects the blood from the ventral side of the œsophagus.

The œsophagus has a very rich plexus of large capillaries similar to that described by Parker (10) in *Mustelus*, save that in *Mustelus* the blood from this plexus is taken to the posterior cardinal sinuses, while in *Scyllium* it goes to the hepatic-portal vein in the manner described above.

7. *The Hepatic Veins and Sinuses* [Pls. I. & II., H.S.]. The hepatic vein is a large thin-walled venous trunk situated at the anterior end of the corresponding lobe of the liver. The two hepatic veins unite just outside the liver to form a large sac, the hepatic sinus, which, when dilated, entirely fills up the space between the ventral body-wall, the œsophagus, the anterior ends of the lobes of the liver, and the pericardio-peritoneal septum.

This sinus is partially divided into two chambers by an incomplete vertical septum formed of interlacing trabeculae. It passes through the pericardio-peritoneal septum and opens into the sinus venosus, however, by two small circular apertures, one on either side of the middle line, by means of which all the blood brought to the liver by the hepatic-portal vein and the hepatic arteries is returned to the heart.

B. THE RENAL PORTAL VEINS.

1. *The Caudal Vein* (Parker) [Pl. I., C.] originates far back in the tail and runs forwards in the hæmal canal ventrally to the caudal artery to a point just posterior and dorsal to the anus. Here it leaves the vertebral column and divides into two large equisized branches, the renal-portal veins. It receives numerous small branches from the myotomes of the tail.

2. *The Renal Portal Vein* (Parker) [Pl. I., R.P.] starts from the bifurcation of the caudal vein and passes forward along the dorsal and dorso-lateral edge of the kidney, to which it sends numerous afferent renal branches. It gradually diminishes in calibre, and dies away towards the anterior extremity of the caudal mesonephros at about the level of the front end of the vesicula seminalis in male. The two renal-portal veins are completely separated in the middle line, and do not communicate directly with the posterior cardinal sinus.

2. i. *The Posterior Oviducal Veins* (Parker) are small veins from the dorso-lateral wall of the posterior portion of the oviduct, and open into the renal portal vein.

2. ii. *The Posterior Parietal Veins* (p.-spinal veins, Parker) arise from the myotomes of the region of the body along the side of the kidney, and open into the renal portal vein on its dorsal side.

VII. THE CORONARY VEINS (Text-fig. 4).

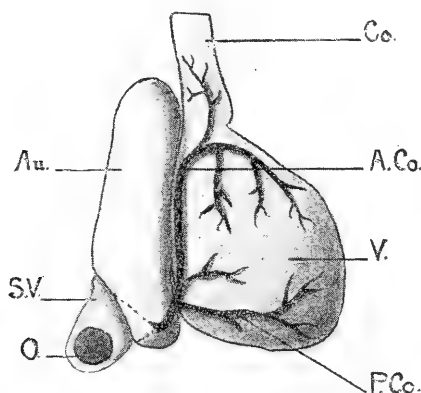
The Coronary Veins are situated one on each side of the heart. Each of them is formed at the posterior end of the furrow separating auricle and ventricle, and enters the sinus venosus just behind the corresponding flap of the sinu-auricular valve. The posterior smaller vein collects the blood from the caudal end of the ventricle, while the remaining one collects blood from the anterior part of the ventricle, and, after receiving a well-marked tributary from the conus arteriosus, runs backwards in the groove between auricle and ventricle. Small factors from the auricle probably join the coronary veins, but are difficult of injection.

VIII. THE DUCTUS CUVIERI.

The Ductus Cuvieri (Parker) [Pls. I. & II., D.C.] convey to the heart all the venous blood save that brought by the hepatic veins. Their anatomical relations in the adult have already been briefly noted. The outer end forms a spout-like structure with an oval end projecting into the posterior cardinal sinus. Each passes

inwards almost horizontally on the ventro-lateral sides of the oesophagus through a very conspicuous notch in the posterior border of the fifth cerato-branchial cartilage up to the lateral wall of the pericardium. It is continuous through this with the sinus venosus.

Text-figure 4.



Lateral view of the heart to show the arrangement of the coronary veins.

For explanation of lettering see p. 454.

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EXPLANATION OF THE PLATES.

Lettering.

- | | |
|--|---|
| A.C. Anterior Cerebral Vein. | L.M. Lateral Myelonal Vein. |
| A.Ca. Anterior Cardinal Sinus. | M. Myelonal Vein. |
| A.Ch. Anterior Choroid Plexus. | M.G. Median Gastric Vein. |
| A.Co. Anterior Coronary Vein. | N.S. Nasal Sinus. |
| A.F. Anterior Factor of A.C. | O. Opening of the Ductus Cuvieri. |
| A.I. Anterior Intestinal Vein. | O.C. Olfactory Capsule. |
| A.L.G. Anterior Lieno-gastric Vein. | O.N. Orbito-Nasal Vein. |
| An. Anastomosis between Posterior factors of A.C. | Or. Orbital Sinus. |
| An. Auricle. | P.An. Pelvic Anastomosis between the two L.A. |
| B. Brachial Vein. | P.C. Posterior Cerebral Vein. |
| Ba. Basipterygium. | P.Ca. Posterior Cardinal Sinus. |
| C. Caudal Vein. | P.Ch. Posterior Choroid Plexus. |
| Cl. Cloacal Vein. | Pe. Pectoral Fin. |
| Co. Conus Arteriosus. | P.I. Posterior Intestinal Vein. |
| D.A.G. Dorsal Anterior Gastric Vein. | Pl. Pelvic Fin. |
| D.C. Ductus Cuvieri. | Pl.C. Pelvic Cartilage. |
| D.G. Dorsal Gastric Vein. | P.L.G. Posterior Lieno-gastric Vein. |
| D.O. Dorsal Oesophageal Vein. | P.O. Post-Orbital Sinus. |
| E. Eye. | P.S. Posterior Splenic Vein. |
| F. Femoral Vein. | R. Portion of the P.I. on the Rectal Gland. |
| G.I. Gastro-Intestinal Vein. | Re. Rectal Vein. |
| G.S.2. 2nd Gill-cleft. | R.P. Renal Portal Vein. |
| H. Hyoidian Sinus. | R.S. Right Spermatic Vein. |
| H.P. Hepatic Portal Vein. | S.C. Sub-Clavian Vein. |
| H.S. Hepatic Sinus. | Sp. Spiracle. |
| I.I. Intra-Intestinal Vein. | S.S. Sub-Scapular Sinus. |
| I.J. Inferior Jugular Sinus. | S.V. Sinus Venosus. |
| Il. Iliac Vein. | T.G. Thyroid Gland. |
| I.M. Intestino-Mesenteric Vein. | V. Ventricle. |
| I.O. Inter-Orbital Vein. | Va. Valve between A.Ca. and P.Ca. |
| K. Caudal Mesonephros. | V.A.G. Ventral Anterior Gastric Vein. |
| L.A. Lateral Abdominal Vein. | V.F. Ventral factor of A.C. |
| L.C. Lateral Cutaneous Vein. | V.G. Ventral Gastric Vein. |
| Le. Lateral expansion of the Posterior Choroid Plexus. | V.O. Ventral Oesophageal Vein. |

PLATE I.

Diagram showing the general disposition of the main venous trunks in *Scyllium canicula*. The more dorsally situated vessels are stippled and the more ventral ones black. For the sake of clearness, the ventral cutaneous vein has been omitted.

PLATE II.

Fig. 1. Sketch of the arrangement of the Hepatic Portal factors seen from the dorsal side. The vessels were injected and the gut hardened and removed whole from the body-cavity.

Fig. 2. Diagram of the main vessels of the anterior end of the Dogfish viewed from the side in order to give their dorso-ventral relations.



31. Notes on Colour Development in the Indian Wood-Stork. By GEORGE JENNISON, Belle Vue Gardens, Manchester*.

[Received April 17, 1914: Read May 19, 1914.]

On June 2nd, 1908, a specimen of *Pseudotantalus leucocephalus*, which I judged to be six months old, came to Belle Vue Gardens with other stock. It was at that time not more than half its present weight, the beak was straight and rather slender, pale yellow in colour. The pinions were of a dull black, the rest of the plumage a yellowish white. The bird ate fish freely, and has not had a day's illness or check of any kind, so we may assume its subsequent development to be normal. The first change was noted in February 1909, when the feathers on the larger wing-coverts were slightly tinged with pink. During the next three years, that is until the spring of 1912, there was a continual change of the yellowish to ever whiter body-feathers, for the moult is extremely gradual and the new plumes make quite a checkered pattern with the old: the dull black of the pinions and tail took on a lustrous greenish tinge, and the bare skin of the head became red where it meets the feathers of the neck.

These changes might pass unnoticed by a casual observer, but in January 1912 a drastic alteration supervened which could not fail to attract attention. The white feathers of the smaller and median wing-coverts of the chest and underparts of the wings were slowly replaced by black feathers, with a narrow edge of white. The perfection of plumage was reached in May, when the whole of the shoulder was a wavy pattern of brilliantly contrasted broad black and narrow white, and the bird in flight showed the same beautiful coloration on the chest and beneath the wings.

The beak changes slowly, first thickening and afterwards taking a pronounced downward curve, which continues to develop long after the plumage-change is completed; its colour changes meanwhile to a deep shiny wax-like yellow. During this time the skin of the head, which can be drawn back an inch or more, also continues to develop until the forehead and cheeks are a deep yellow-umber and the hinder part of the head becomes a rich purple.

The legs are now (1914) showing signs of a remarkable alteration; for five years they were grey with a slight tinge of pink on the toes, the upper half of the tarsus is now a deep magenta-red.

* Communicated by the SECRETARY.

32. Scent Organs in Trichoptera. By BRUCE F. CUMMINGS, British Museum (Natural History) *.

[Received April 3, 1914 : Read May 19, 1914.]

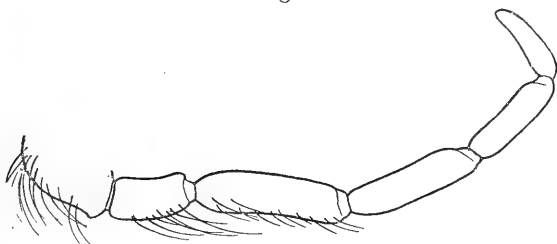
(Text-figures 1-8.)

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INTRODUCTION.

Sericostoma personatum Spence is a tolerably common caddis-fly in Great Britain, and immediately attracts attention on account of the enormous development of the palpi of the first pair of maxillæ in the male. Unlike the maxillary palpi of the female, which are 5-jointed and quite normal (text-fig. 1), the maxillary palpi of the male consist of but a single segment very much enlarged and shaped like a half-moon. These two palpi are placed together and held vertically so as to mask the front of the head (text-fig. 2, p. 463).

Text-figure 1.



Sericostoma personatum.

Palpus of the first maxilla, ♀. $\times 17$.

Despite their bizarre shape, these palpi have not obtained, so far as I am aware, that amount of enquiry into their nature and function which they deserve, and a résumé of their uneventful entomological history therefore will not detain us long.

i. HISTORICAL.

Kirby & Spence (1) regarded them as the genæ or cheeks of the skull. Pictet (2), as McLachlan gravely points out, "scarcely

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committed himself" to any direct statement as to the number of segments, though it seems more than likely, from an expression on p. 20 of his 'Recherches,' that he regarded three as probable. Stephens (3), p. 148, assumes two to be the number. Burmeister (4) says that according to his experience the segments of the maxillary palpi are only two in number. Rambur (5) agrees with this, and makes the observation regarding the "fluff" on the inner surface of the two palpi that it is perhaps not produced until some time after the insect has emerged, as all specimens do not possess it. Kolenati (6) arrives at the astonishing conclusion that there are four segments, the second being galeate and the third and fourth more slender. McLachlan (7) is cautious, and says "they are probably 3-jointed, but the basal joint is scarcely separable from the sides of the face and the second joint . . . is ill-defined and transverse." A very brief and somewhat inaccurate description of the palpi follows. McLachlan's account appears to have set the matter at rest in the minds of Trichopterists, for Ulmer (8) in 1907 echoes the former's opinion that three segments are present, the first and second being ill-defined.

It is necessary to point out at once that, as will be seen on examination of text-fig. 2, McLachlan mistook the cardo and stipes of the first maxilla for segments of the palpi. A paper by W. Müller (9) in 1887 appears to have been overlooked, for here not only is the maxillary palpus described correctly as one-jointed, but convincing evidence is brought forward showing that these palpi serve as scent organs. Müller observed the large tuft of elongate hairs (McLachlan's inelegant but expressive "fluff") on the inner surface of the palpi and compared them with similar hair-tufts in the males of some Lepidoptera.

During copulation, one individual was seen "seine Palpen auseinander zu spreizen und die in denselben liegenden Haarbüschel zu entfalten," so that they surrounded the head "wie ein Heiligenschein." A strong smell of vanilla was emitted.

ii. SCENT ORGANS IN INSECTS.

By "scent organ" the entomologist usually means those glands which, secreting an attractive odour and being confined to the male sex, are supposed at mating time to charm or stimulate the females. Such scent glands, well known in the Lepidoptera, are situated at the bases of hairs arranged in tufts or at the bases of specially modified scales (called androconia) (10). Typical scent organs like these occur not only in the Lepidoptera (11) (12), but also in Coleoptera (*Blaps mortisaga*) (13), Blattidæ (15), and, as now appears, in Trichoptera (*Sericostoma personatum*).

Another type of scent gland occurs in insects. This assumes the form of fairly long eversible tubular filaments, usually two in number, and is known in the males of some Lepidoptera, *Spilosoma virginica*, *Arctia virgo*, *Haploë clymene* (10), and in the males of the Cricket, *Hadenæcus subterraneus* (17). Similar

retractile tubular filaments have not yet been described from the Trichoptera.

Under the term "scent glands" it is necessary also to include those hypothetical organs the emanation from which, in the females of certain moths, is supposed, in the well-known phenomenon of "assembling," to attract males from long distances. These *alluring* glands have not, I believe, been actually located, nor has the nature of such emanation been ascertained. Of course odoriferous glands undoubtedly do exist in many female Lepidoptera, and recently Ernst Urbahn (21) has made a detailed study of these glands, which are restricted to the abdomen and occur as intersegmental sacs, folds, and so on.

Then, again, in insects like the Musk Beetle (*Aromia moschata*), scent glands of still another type are found. These are pluricellular and open to the exterior by an aperture. In *Aromia* they are present in both sexes, though the aroma is stronger in the female, while the male is the more active organism.

It is often difficult to distinguish scent glands of this type from stink or repugnatorial glands used in self-defence. The resemblance is increased by the fact that some organs which have been described as stink glands, *e.g.*, in the Cockroach, *Phyllodromia germanica* (16), are nevertheless limited to the male. On the other hand, sac-like glands at the end of the abdomen of a Cricket, *Ceuthophilus maculatus* [(10) p. 393], occurring only in the male, are regarded as scent glands*.

There is, indeed, a widespread confusion in the literature of the subject, and it is difficult or impossible, in the present state of our knowledge of the natural history and mating habits of these insects, to say whether glands, occurring as they may in one sex only or in both, are of sexual import or are used in self-defence. *A priori*, stink glands if used in self-defence, one would expect to be either common to both sexes or, if limited to one sex, to occur in the female rather than the male†.

The occurrence of typical unicellular scent glands at the bases of hairs in Trichoptera as well as in Lepidoptera is interesting, and in view of the close relationship of these two Orders, not wholly unexpected. But in consequence of the common occurrence of scent glands in other insects besides Lepidoptera and Trichoptera, this cannot be taken in itself as evidence of phylogenetic affinity any more than can the presence of scales, which are also present in Trichoptera and Lepidoptera, but which occur also in Thysanura and other insects. Further, in *Sericostoma*, as will presently be shown, they occur on the

* The organs, called by their discoverer, Kraus, "duft organe" in *Aphlebia bivittata*, are named by Berlese "ghiandole repugnatorie."

† The stink gland, of course, must have been independently acquired very many times, for it is a device for self-defence adopted by many animals in very different phyla of the Animal Kingdom (*e.g.* Myriapods and Mammals). Scent or alluring glands are also common. The mammalian anal, preputial, and inguinal glands are doubtless of sexual importance on account of their odoriferous secretions. Odoriferous glands occur also in crocodiles and snakes.

maxillary palpi, a position in which, I believe, they are unrecorded in the Lepidoptera.

Although Kellogg (18) has described and figured special plumules and scale-like hairs on the wings of Trichoptera, *e. g.*, *Mystacides punctata*, which function probably as androconia, scent organs have not, I think, been hitherto examined anatomically in this Order, for even in the paper in which Müller gives us an account of his discovery of the true function of the extraordinary palpi of *Sericostoma*, no account is included of the structure either of the palpi or of the glands.

In *Sericostoma* they differ in position from the scent glands of other insects. Scent glands are found on the abdomen or on the thoracic appendages. According to Berlese [(12) p. 525] odoriferous scales have been found on the palpi of some Saturnine butterflies, but he does not say whether they are the labial palpi or the maxillary palpi. Probably they are the former. Well-developed and characteristic scent organs occur in the labial palpi of an Indian butterfly, *Bertula chalybialis*; this, and the case of *Sericostoma personatum*, form the only well authenticated instances known to me of scent organs in the head, in the one case on the labial palpi and in the other on the maxillary palpi.

When not in use, the hair-tufts on the legs of the Lepidoptera with scent organs are often concealed in cavities, just as the hair-tuft of *Sericostoma* is concealed within the cavity of the inner surface of the maxillary palpi.

I anticipate that among the many strange modifications of the maxillary palpi of the males of many genera in the Family Sericostomatidae, sometimes densely clothed with large black striated scales (*Gæra* and *Lepidostoma*), scent organs will be commonly found and their occurrence in the Trichoptera be very generally recognised.

It is evident that scent glands in insects are of fairly common occurrence and have been independently acquired over and over again. According to Berlese, hairs like androconia have been described from the wings of Diptera.

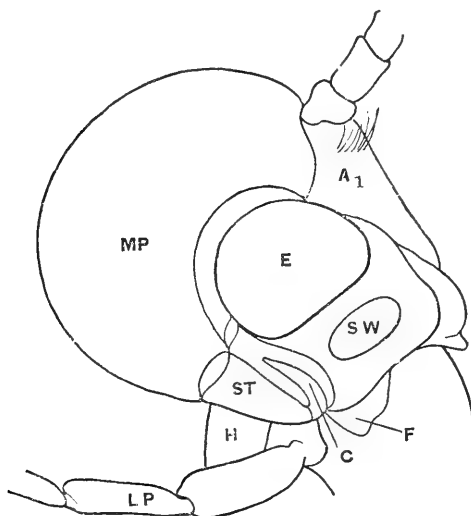
iii. THE MAXILLARY PALPI OF *SERICOSTOMA PERSONATUM*.

Each palpus in outline is something like a half-moon. The outer surface is convex and strongly chitinous, dark brown in colour, with scattered short black hairs. The inner surfaces of the two palpi, which are carried closely apposed to each other, are concave, but their concavities are filled up to a level surface with an extremely thick felting of very long golden-yellow silky hairs. Until the palpi are separated with a needle the one from the other, the yellow felting lining the inner sides cannot be seen, or seen only with difficulty by looking at them edgeways from in front.

Both the palpi are held vertically with their broad surfaces facing

laterally (text-fig. 2). Together they entirely cover up the front of the head or clypeal region. Their tips are received each into a slot or excavation of the inner side of the enormously enlarged basal joints of the antennæ (text-figs. 4 & 5); emerging from underneath the palpi may be observed the tip of the white fleshy haustellum, the white tip of the labium and the lobes of the first maxillæ.

Text-figure 2.

*Sericostoma personatum*, ♂.Head, side view (diagrammatic). $\times 22$.

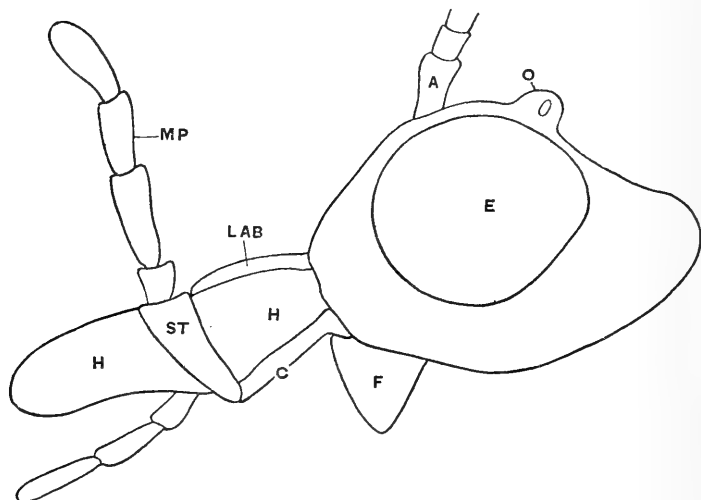
E. Eye. *A₁*. First segment of the antenna. *F.* Genal flap. *C.* Cardo. *ST.* Stipes. *H.* Haustellum. *MP.* Palpus of the first maxilla. *LP.* Palpus of the second maxilla. *SW.* Subocular wart.

In order to understand the modifications which have been drawn in the train of the enormous enlargement and porrection of the maxillary palpi, a few words are necessary upon the maxillary palpi and the structure of the head in other Trichoptera. In this Order, with the exception of *Plectrotarsus*, *Chimarrha*, and *Ptilocolepus**, the lower side of the skull is incomplete, the gular region from the occipital foramen to the labium being soft and membranous. On either side the two

* The species examined were *Plectrotarsus gravenhorstii* Kolenati, *Chimarrha argentinea* Ulmer, and *Ptilocolepus granulatus* Pictet. *P. gravenhorstii* is the only species known belonging to its genus, and in the other genera it has been assumed that the observations following, recorded for the particular species, apply as well to the rest of the species of the genus.

genæ are drawn out ventrally into flaps, usually triangular in shape, which hang down as strong perpendicular walls beside the soft gular region (text-fig. 3, F).

Text-figure 3.



Phryganea, ♂.

Side view of the head (diagrammatic). Much enlarged.

E. Eye. *O.* Ocellus. *A.* Antenna. *F.* Genal flap. *C.* Cardo. *ST.* Stipes. *LAB.* Labrum. *H.* Haustellum. *MP.* Palpus of the first maxilla.

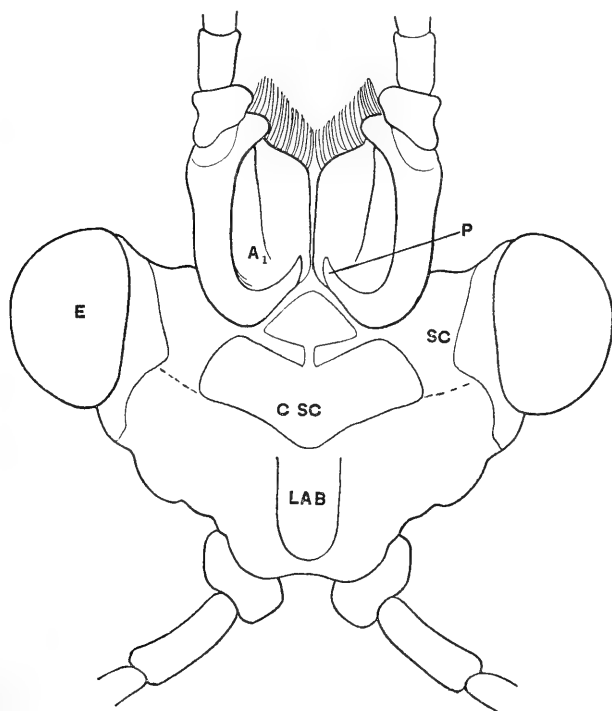
The cardo and stipes are not free like the four joints of the palpus, but are attached by their inner surfaces to the sides of the haustellum. Maxillary lobes not shown.

For the sake of convenience it is easy to divide the mouth-parts of adult Trichoptera roughly into those with a very elongate haustellum*, and with no mandibles or with the mandibles much reduced, and those with a shorter haustellum and a pair of powerful well-developed mandibles. In the former case, for example in *Phryganea* and *Limnophilus*, the cardo of the first maxilla is articulated to the head in a small angle or niche formed at the point where the gena curves down as the triangular flap (text-fig. 3, F). In these genera, both cardo and stipes are elongate and lie along each side of the stalk or peduncle of the haustellum and carry off the maxillary palpi at their distal end some distance away from the head. In the latter case, for

* Haustellum was the name given by Lucas (19) to what he regarded as an enormously developed fleshy labium projecting from the head as a sort of proboscis by means of which caddis-flies obtain their nourishment. In reality the haustellum is a modification of the region of the hypopharynx.

example in *Rhyacophila*, the cardo and stipes are much shorter, so that the maxillary palpi are carried close to the head instead of at a distance from it. In such cases the angle or niche in which the cardo is articulated is much larger, and in this angle the cardo is attached to the head by the whole of its inner surface, whereas in *Phryganea* and others this angle or

Text-figure 4.

*Sericostoma personatum.*

Head from in front with the palpi and lobes of the first maxillæ dissected off (diagrammatic). $\times 36$.

E. Eye. *A₁*. First segment of the antenna, excavated to receive tips of the palpi. *P.* Upturned process. *LAB.* Labrum. *SC.* Soft chitin. *C.SC.* Clypeal sclerite.

niche receives only the proximal end of the cardo, which is provided with a stout condyle for the attachment of a powerful muscle arising from the tentorium. The stipes is carried at right angles to the cardo, so that the general direction of the palpi is dorsal. The female of *Sericostoma personatum* agrees

with this general description; but in the male the angle or niche has developed into a deep somewhat rectangular excavation of the gena, which is carried right back as far as the lower part of the eye and the subocular wart. Above it is bounded by the lower margin of the clypeus. The whole of this area (text-fig. 2) is reserved for the cardo and stipes which are very closely attached along their inner surfaces. The stipes has been forced back close to the head and back upon the cardo, both cardo and stipes being almost vertical in direction (text-fig. 2, ST & C). The stipes is a long sclerite, narrow at the base, broadening out gradually towards the distal end, where the palpus is inserted. It apparently gives only the slightest support to the maxillary lobe, as the stipes always comes away from the latter in dissection with great ease, and the chitinous bar, which in other Trichoptera the stipes sends in as a supporting connection with it, cannot be discovered. The cardo is much reduced, being visible at the side as a narrow chitinous splint.

Thus the two maxillary palpi completely cover the clypeus and front of the head, and their chitinous, convex, outer surfaces form a kind of mask or false front, beneath which the chitin of the clypeus has become thin and in places delicate and transparent (text-fig. 4, SC).

The labrum is fairly large, with a knob or enlarged basal piece. The mandibles, though present, are very much atrophied, but may be detected in a careful preparation one on either side of the base of the labrum, as a pair of thin pointed splint-like pieces of chitin. In most other Trichoptera well-developed mandibles are commonly found.

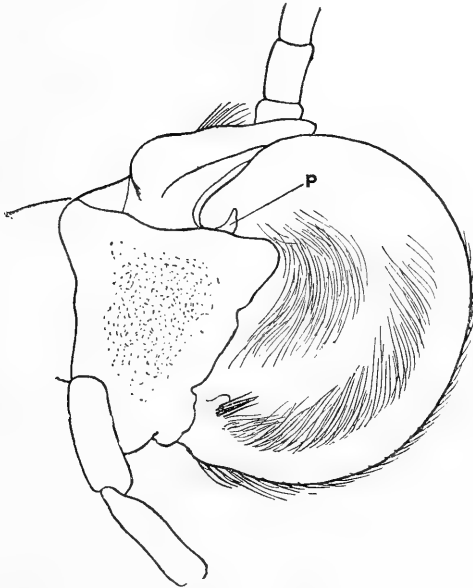
The basal joint of the antenna requires further description. Text-fig. 5 is a sagittal section of the head and gives a view of the relations between the maxillary palpus and the antenna. Text-fig. 4 gives a view from in front after both the palpi and lobes have been removed.

From an inspection of these figures it should be clear that these enlarged basal joints meet each other behind, but are excavated in front on their inner surfaces to receive the tips of the ascending maxillary palpi. The inner front part of each basal antennal joint is scalloped out into a slot into which the palpus tip is neatly fitted and locked by means of the little upturned process (text-figs. 4 & 5). The tip of the palpus also is modified to serve this end, as is mentioned and illustrated further on (see p. 468, Section iv.).

In addition to the mask or false front to the head formed by the palpi there is also a false top to the head formed by these two greatly enlarged basal segments of the antennae, which extend backwards nearly as far as the occiput, covering nearly the whole of the top of the head. The whip-like remainder of the antenna springs, as if from the head itself, from the extreme anterior corner of this large basal segment. Each basal segment on the inner excavated side is white in colour and composed of

two "windows" of thin delicate chitin divided by a median bar of thicker chitin running dorso-ventrally. The segment itself is almost immobile, but its enlarged size allows for the presence of muscles by which the long whip-like remainder of the antenna can be moved.

Text-figure 5.

*Sericostoma personatum*, ♂.

Sagittal section of the head, with the palpus of the first maxilla and the first joint of the antenna seen from the inside (diagrammatic). $\times 27$.

The shape of the tentorium appears to indicate limited antennary movements, as the two columnar endosternites or supporting pillars, which run from the cross-bar at the occipital foramen across the inside of the head to the clypeus, are simple, without wings or lateral expansions from which, when present in *Phryganea* and other genera, arise numerous powerful muscles to the antennæ. In the female of *S. personatum*, where the antennæ have much smaller basal segments, the tentorium is, however, similar to the tentorium of the male in the absence of its wings.

The head of the female is more or less normal. The maxillary palpi are fairly long 5-jointed appendages; the chitin of the clypeus is dark brown in colour and of equal thickness to that of the rest of the head. The mandibles are also much longer,

being visible under a strong power without the need of special microscopic preparation. The first segment of the antenna, though much larger than the succeeding segments, is separated from the first segment of the other antenna by a wide space, and bears no sort of resemblance to the eccentric form of these segments in the male. The cardo is also much larger than the cardo in the male, and instead of being practically vertical beside the vertical stipes it is at right angles to the latter. The stipes is shorter and broader than the same piece in the male, and the palpi are so hinged upon it as to point outwards and away from the head.

iv. THE SCENT ORGANS OF *SERICOSTOMA PERSONATUM*.

More detailed examination of a detached palpus of a male reveals the following additional facts.

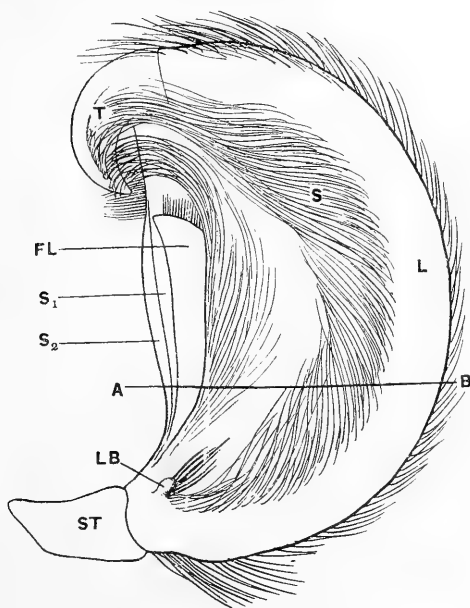
The deep brown, comparatively thick chitin of the convex outer side ceases abruptly in a transverse line towards the tip so as to leave the soft white tip of the palpus (composed of thinner chitin of a lighter colour) to fit more easily into the base of the antenna. On the inner surface at the base is a small lobe with two or three short black bristles at its base (text-fig. 6). These bristles in cross-section are seen to be fluted.

In side view the outer margin is very convex, the inner margin, which is applied to the head, more or less straight. The outer surface is very convex, and the inner surface applied to the inner surface of its fellow is concave. But the concavity is full of very long silky hairs, which curve up and around in a semicircle to protrude near the tip into the hollow in the base of the antennæ. In the figures only a few of these hairs are sketched in. This huge hair-tuft is bounded on the outside by a rather pronounced lip, bare except for a row, on the margin, of small black bristles, in cross-section seen to be fluted (text-fig. 7, FH), and on the inside by a flap (text-fig. 6, FL), which projects and keeps the hairs tucked in so that they are prevented from straying in an untidy mass on both sides. Further reference to this flap is given below. It runs down towards the base of the palpus, where it is continuous with the "lip" of the convex outer margin. Higher up it carries a fringe of hairs much shorter and stouter than the silky hairs of the scent-gland tuft. The ends of these hairs are somewhat swollen. The flap ends abruptly higher up so as to leave a channel between it on one side and the lip of the palpus opposite on the other side. Between these two promontories the long hairs sweep out beyond the edge of the palpus, and are sometimes visible as "fluff" projecting from between the two basal antennal segments behind.

Under the flap is the opening into a large sac which occupies the whole of the interior of the palpus from the top to its extreme bottom near the stipes.

Beneath this sac is another sac which opens by a longitudinal slit along the inner margin of the palpus beneath the opening of the first sac. At first I thought this sac was only an artefact, imagining that the membrane lining the hard chitinous convex surface of the palpi had come away. But sections showed the existence of a distinct cellular lining to the inside of this chitin, and there can be no doubt that the sac in fact exists.

Text-figure 6.

*Sericostoma personatum*, ♂.

Palpus of the first maxilla, seen from the inside with most of the silky hairs removed (diagrammatic). $\times 39$.

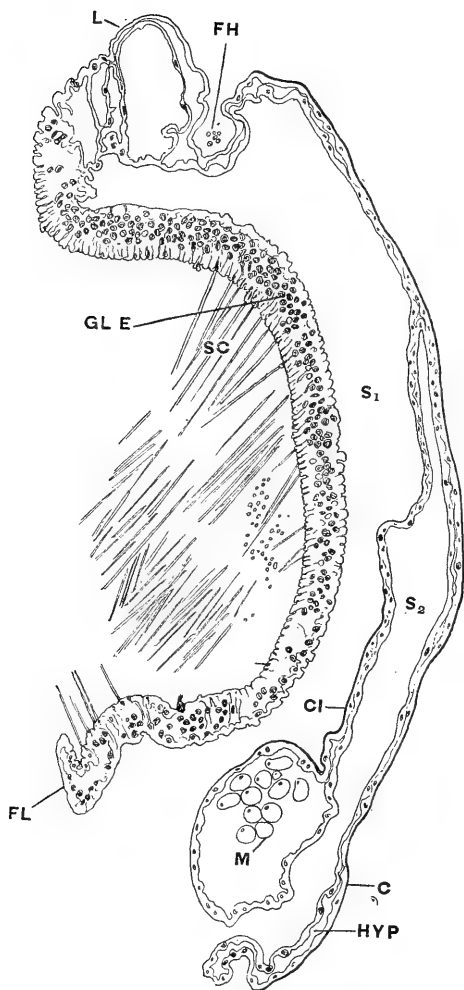
ST. Stipes. L. Lip. LB. Lobe. FL. Flap. S₁. Entrance to sac 1.
S₂. Entrance to sac 2. S. Scent hairs. T. Tip of palpus.

A study of transverse sections of the palpus affords us the following histological information.

Text-fig. 7 is through the line AB in text-fig. 6. It shows the two sacs and the septum between them, and the layer of large, deeply stained, glandular cells at the base of the silky hairs.

The hypodermis beneath the outer, convex cuticle of the palpus is composed of a double layer of flat squamous cells. The septum between the two sacs is formed by the innermost cell-

Text-figure 7.

*Sericostoma personatum*, ♂.

Transverse section along the line AB in text-fig. 6. Length of section 1.1 mm.

*S*₁, Sac 1. *S*₂, Sac 2. *FL*, The Flap. *L*, Lip. *FH*, Fluted hairs. *GLE*, Glandular epithelium. *C*, Cuticle. *HYP*, Hypodermis. *SC*, Scent hairs. *CI*, Chitinous intima. *M*, Muscle-fibres.

layer which runs up to encircle a number of muscle-fibres. This septum is stiffened by a comparatively thick chitinous intima (text-fig. 7, CI), which runs in from the entrance to cover about half of the outside wall of the inner sac.

In the sections, the "lip" (L) has been accentuated owing to the sinking in of the tissues beneath it to form a hollow where the fluted edges of the sections of the dark hairs are seen. Under this lip the two squamous layers of cells are widely separated the one from the other and the space between them traversed by strands. The cells are also larger.

On working round to the inner surface of the palpus one finds the concavity full of an immense thickness of hairs seen to be circular in cross-section and containing a central canal of small bore. The cuticle supporting these hairs is produced into elongate papillæ containing the alveoli in which the scent hairs are fixed. Beneath the cuticle the hypodermis consists of a glandular epithelium of elongate cells, specialised formative cells called by Graber trichogens, in which the scent is secreted [(10) p. 188]. On account of the fact of the immense number of these cells and of the hairs which they support, it has not been easy, from an inspection of sections of unfixed material, to say definitely whether there is a single trichogen cell to each hair or whether there are several (text-fig. 8). Usually in the scent organs of the Lepidoptera there is one cell—one hair; but Bertkau (20), in the case of the Noctuid genera *Hadena* and *Dichronia*, points out that there is not one giant cell to each of the hairs of the scent tuft (which are of enormous length), but several smaller cells belong to each hair.

That these hairs may act as scent organs it is necessary for them to remain in connection with the living hypodermic tissue.

Text-fig. 8 shows how a pore-canal or channel runs up to the base of each alveolus through the chitinous papilla, thus putting into communication the cutaneous appendage with the hypodermic trichogen cell.

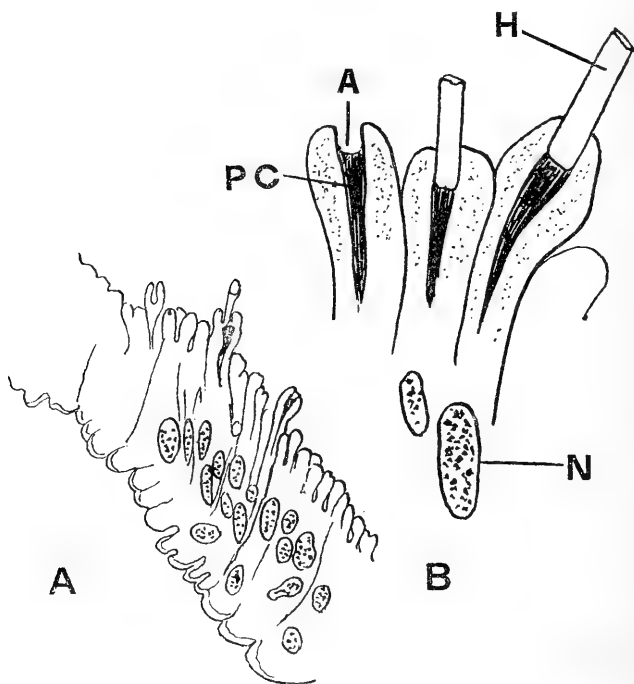
No opening pores were found either at the base of or at the tip of the hairs, and probably the scent secretion runs up the canal within the hairs by capillary attraction and becomes diffused by osmosis into the outer air. In the androconia and scent hairs of the Lepidoptera it is now generally held [Berlese (12) p. 533] that the secretion reaches the air by osmosis, as apertures in the integumentary appendages are no longer thought to exist.

The cuticle of the inner surface is plicate and the hypodermic cells are much smaller. Strands of tissue run across between the hypodermis of the inner and outer layers, being very clearly seen where the two layers of cells diverge from each other in the "lip."

It will be remembered that Müller (*supra*, p. 460, Section i) describes the male during mating as separating the maxillary palpi and spreading out the hair around the head "wie ein Heiligen-

schein." As a result of my study of these palpi, no very clear or concise expression of the manner in which this is done can be offered. No longitudinal muscle-fibres as they occur, for example, at the base of scent hair-tufts in some Butterflies, were discovered attached to the bases of the hairs. A circular muscle around the hair within the alveolus, but at some point above the base, would serve to erect the hair. No such muscle has been detected.

Text-figure 8.



Sericostoma personatum.

A. Portion of the glandular epithelium, enlarged. Actual width varies from '053 to '03 of a millimetre.

B. Some trichogen cells very greatly enlarged.

Reichert objective $\frac{1}{2}$ homog. imm., with eyepiece No. 4 was used for the examination of the cells. The drawings are free-hand.

A. Alveolus. H. Hair. PC. Pore-canal. N. Nucleus.

It remains to consider the action of the stout muscle-fibres in the edge of the septum previously described. Their course is longitudinal from the base of the palpus to near the end. The result of their contraction would be to draw down the tip of the palpus and so make the convex outer margin still more convex,

in which event the long silky hairs, which are curved and so fit the normal amount of the convexity of the outer margin of the palpus, would slip out of their concavity over the "lip" of the outer convex edge and project as a "frill." This action is often suggested while manœuvring the detached palpus in the dissecting dish. Again, if we suppose that the palpi by the aid of their muscular attachments to the stipes can be easily divaricated the one from the other and their inner surfaces exposed, it seems probable that the natural resilience of the hairs in the live animal would account for their erection, as they are inserted at right angles to the surface on which they stand, but in repose are flattened down upon it because the two palpi are then held closely apposed to each other. Perhaps also in the live animal the natural elasticity of the inner surface of the palpus may result, when exposed as a free surface, in its becoming swollen and convex, rather than as in spirit-specimens, concave.

I do not think that the resemblance between the scent glands of Lepidoptera and those of Trichoptera can very profitably be carried into histological details. The papers on scent glands in Lepidoptera which I have consulted all show in one particular or another considerable differences from those of *Sericostoma personatum*, as, for example, in the presence of muscle-bands, in the arrangement of the trichogen cells, or the shape of the pore-canals and the position of the hair-tuft.

I have to thank Mr. Martin E. Mosely for kindly giving me the material for this study, Prof. Maxwell Lefroy for allowing me to work in the Laboratory at the Imperial College of Science and Technology, and Mr. E. Hargreaves for assistance in section cutting.

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EXHIBITIONS AND NOTICES.

March 17, 1914.

Prof. E. A. MINCHIN, M.A., F.R.S., F.Z.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the additions to the Society's Menagerie during the month of February 1914:—

The number of registered additions to the Society's Menagerie during the month of February was 157. Of these 95 were acquired by presentation, 14 by purchase, 20 were received on deposit, 5 in exchange, and 23 were born in the Gardens.

The number of departures during the same period, by death and removals, was 188.

Amongst the additions special attention may be directed to:—

1 Pigmy Antelope (*Neotragus pygmaeus*), from Accra, Gold Coast, new to the Collection, presented by E. B. Reece on February 4th.

2 Urial Sheep (*Ovis vignei*), from Jhelum, presented by Capt. T. H. Scott on February 5th.

1 Wild Boar (*Sus scrofa*), from Antioch, presented by the Officers of H.M.S. 'Duke of Edinburgh' on February 25th.

1 Colpeo Dog (*Canis culpæus*) and 1 Salt-Desert Cavy (*Dolichotis salinicola*), from Cordova, presented by Wilfred A. Smithers, C.M.Z.S., on February 4th.

1 Slow Loris (*Nycticebus tardigradus*) and 2 Finlayson's Squirrels (*Sciurus finlaysoni*), from Koh Si Chang, Siam, presented by Commander Robert E. Buske-Peel on February 27th.

1 Graceful Mocking-Bird (*Mimus gilvus*), from Central America, new to the Collection, presented by Hubert D. Astley, F.Z.S., on February 3rd.

2 Tooth-billed Tanagers (*Pyrranga bidentata*), from Central America, new to the Collection, received in exchange on February 11th.

2 Cinnamomeous Kestrels (*Cerchneis cinnamomina*), from Cordova, Argentina, new to the Collection, presented by Wilfred A. Smithers, C.M.Z.S., on February 4th.

Mr. G. C. ROBSON, B.A., read a report on Mollusca from Dutch New Guinea collected by the British Ornithologists' Union and Wollaston Expeditions. In general, the collection appears to endorse Hedley's views as to the Oriental affinities of the Papuan molluscan fauna. Though numerically small in species and individuals, the collection has yielded two new genera and three new species, the anatomy of all of which is described. The two new genera, which were obtained from considerable altitudes, viz. 10,500 ft. and 14,200 ft. respectively, are of considerable

interest, though their precise affinities are as yet uncertain. In any case they cannot be regarded as typical members of the Zonitidæ, though an aggregate of anatomical characters exhibits the characters of that family. An account of the anatomy of *Papuina lituus* (Lesson) is given, and discrepancy between the anatomical and conchological relationships of a new species of *Papuina* is discussed.

This paper has been published in the TRANSACTIONS.

MR. K. G. BLAIR, B.Sc., read his report on the Heteromorous Coleoptera collected by the British Ornithologists' Union and the Wollaston Expeditions in Dutch New Guinea.

The most interesting feature of the collection, from the point of view of distribution, is the occurrence of *Cissites maxillosa* Fab. in this region. This beetle has been hitherto regarded as peculiar to the Oriental Region, its range extending from Assam to Java, Borneo, and the Philippine Islands; it has also been found in Ceylon.

The three species of *Amarygmus* belong to a section of the genus that makes New Guinea its headquarters; a few species of this section are found in the extreme north of Australia, but the majority of the Australian species belong to other groups.

Of the fourteen species noted, seven are described as new.

This paper will be published in the TRANSACTIONS in due course.

Palatal growth in mouth of Camel.

MR. R. H. BURNE, M.A., F.Z.S., exhibited a specimen of the palate of a female Bactrian Camel (*Camelus bactrianus*) and a lantern-slide of a dissection of the throat of a male Common Camel (*Camelus dromedarius*)* (text-fig. 1), and drew attention to a pendulous outgrowth from the roof of the mouth.

This outgrowth or palatal appendage is situated several inches in front of the free posterior border of the palate and is continuous on either side with the anterior pillars of the fauces. It is rudimentary in the female, but of large size in the male where it forms a great flaccid mass of tissue 11 inches (28 cm.) long, hanging down the throat for some distance beyond the larynx.

Short accounts of this appendage are to be found in many of the older anatomical text-books†, and it has recently been briefly described by Prof. Lesbre in his monograph on the anatomy of the Camel‡.

It is a secondary sexual organ which during rut, when the animal is excited, is protruded from the mouth "to the accom-

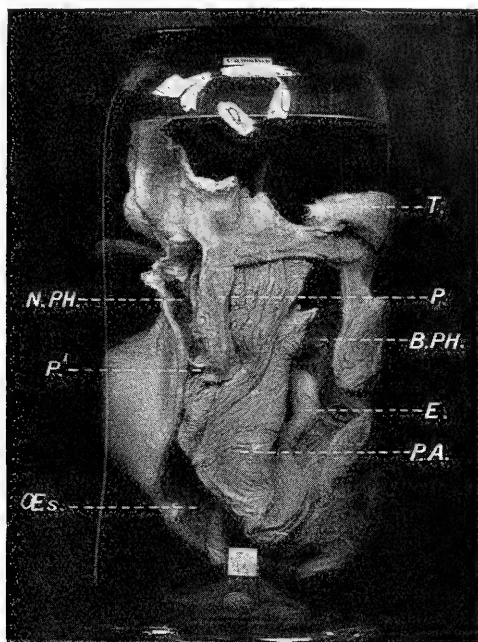
* R. Coll. Surg. Museum No. 1497, Physiol Series, Hunterian specimen.

† Buffon, Cuvier, de Blainville, Owen, Milne Edwards.

‡ Lesbre, Arch. Mus. Hist. Nat. Lyons, t. 8, 1903.

paniment of an abominable gurgling noise" as a "thin membranous bladder . . . until it is as large as the animal's head" *.

Text-figure 1.



Pharynx of Camel, opened from the right side.

B.P.H., buccal pharynx; *E.*, epiglottis; *N.P.H.*, naso-pharynx; *O.E.s.*, oesophagus; *P.*, soft palate (cut edge); *P'*, posterior free margin of soft palate; *P.A.*, palatine appendage; *T.*, base of tongue.

From published descriptions of the process and from remarks made by Prof. Minchin and others at the meeting, it appears as though the appendage were protruded by inflation with air, but a careful examination of the specimen figured above revealed no hole or passage leading from the naso-pharynx or elsewhere through which air could be forced into the interior of the organ. The only indication of anything of the kind was a shallow cleft or recess in the mid-line of the floor of the naso-pharynx above the root of the appendage. But the size of this pit (3.5 cm. long and 2.5 cm. deep) even allowing for considerable powers of distension, was not great enough to suggest that it could by any possibility be sufficiently blown out to fill the whole interior of the appendage.

* Spencer & Gillen, *Across Australia*, 1912, vol. i. p. 38, fig. 17.

Judging by feel and by the parts of the interior of the appendage exposed by cuts, it would appear that the organ is solid and composed of very delicate, loose, areolar tissue. Injection of water or air through a cut upon the surface caused immediate and extensive inflation of this tissue, with the exertion of very little force. Protrusion may, therefore, be due to the infusion of fluid (lymph ?) into the substance of the organ, though possibly inflation of the above-mentioned pit in the naso-pharynx may be accessory to the protrusion by exerting pressure upon the fluids contained in the more distal parts of the appendage.

On the Feet of Domestic Dogs.

(Text-figures 1-3.)

Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., Curator of Mammals, exhibited a series of lantern-slides illustrating some points in the structure of the feet of domestic breeds of dogs (*Canis familiaris*), and remarked:—

“According to F. Cuvier and Geoffroy St. Hilaire (Hist. Nat. Mamm. ii. no. 166, 1820), the interdigital integument of Newfoundland dogs extends almost to the claws and widens to such an extent as to make the feet palmated. In this respect, according to these authors, the feet of this breed differ from those of the majority of breeds in which the web in question is of small extent and reaches only as far as the origin (proximal end) of the second phalanx; but, they add, ‘the peculiarity found in the Newfoundland dog is not restricted to that breed, but is observable in several of our [French] breeds, and especially in those not belonging to the category of running dogs.’ St. Hilaire restated the fact about the feet of the Newfoundland dog in 1862 (Hist. Nat. Gén. iii. p. 450).

In ‘The Variation of Animals and Plants under Domestication,’ i. p. 49, ed. 1905, Darwin, after referring to St. Hilaire’s later work, wrote: ‘In two Newfoundland Dogs which I examined, when the toes were stretched apart and viewed on the underside, the skin extended in a nearly straight line between the outer margins of the ball of the toes, whereas in two terriers of distinct sub-breeds, the skin viewed in the same manner was deeply scooped out.’

This description is not very intelligible. It neither confirms nor contradicts Cuvier’s statement, because the point on the margin of the balls of the toes to which the skin was attached is not given. Moreover, no web can extend between the outer margins of the toes. It must stretch across the middle line between the third and fourth toes, and from the outer margins of the latter to the inner margins of the second and third, respectively. Setting these difficulties aside, however, it will be seen that Darwin did not allude to any difference between the

feet of Newfoundlands and terriers with respect to the forward extension of the skin between the digits.

He also referred to a record by Mr. Greenhow of the occurrence in Canada of a peculiar dog with 'half-webbed feet' which was 'fond of the water' (Loudon's *Mag. of Nat. Hist.* vi. p. 511, 1833), and quoted Mr. C. O. Groom Napier to the effect that the hind feet of otter-hounds are more webbed than those of harriers and blood-hounds ('*Land and Water*,' ii. p. 270, 1866).

Darwin; it may be added, attributed this alleged peculiarity in the feet of water-dogs partly to unconscious selection by man and partly to the inherited effects of use. Finally, as suggestive of the correctness of the above-mentioned statements respecting the webbing of the feet of Newfoundland dogs, we find 'well-webbed feet' enumerated amongst the show-points of this breed (J. J. Cooper, '*The Kennel Encyclopædia*,' iii. p. 942, 1908).

On the other hand, so long ago as 1861 or thereabouts, J. G. Wood wrote (*Illustrated Nat. Hist.* i. p. 271): 'Some people fancy that the Water Spaniel possesses webbed feet, and that its aquatic prowess is due to this formation. Such, however, is not the case. All dogs have the toes connected with each other by a strong membrane, and when the foot is wide and the membrane rather loosely hung, as is the case with the Water Spaniel, a large surface is presented to the water.' Now since it is generally admitted that the Newfoundland belongs to the same group of dogs as the Water Spaniel, it is difficult to find any reason why the larger form should have better-webbed feet than the smaller, since both are what are called 'water-dogs.' Be it remembered, too, that Cuvier's statement about the feet of Newfoundlands does not refer to the 'looseness' of the interdigital web, but to its extension along the edges of the pads nearly up to the claws; and, as quoted above, this author asserted the existence of similar webs in other European breeds excluded from the category of running dogs.

Being unable to procure the feet either of a Newfoundland dog or Otter-hound, I wrote to Mr. J. Sidney Turner, M.R.C.S., F.L.S., about the former breed and I venture to quote his reply. 'There is no doubt that Cuvier's statement that the feet of Newfoundland dogs are more webbed than those of other dogs is a pure myth. I have heard the same statement made about Otter-hounds, but that is of course also wrong. The fact is, that both these breeds have rather larger or longer feet than usual compared with Mastiffs and Foxhounds. I mean that the feet are not so compact and drawn up, and therefore the webbing is rather more apparent, but it extends no farther along the phalanges of the toes.' This is practically what J. G. Wood said about the Water Spaniel. And to clinch the matter so far as the Newfoundland is concerned, Mr. Vero Shaw, the only modern author, as Mr. Turner informed me, to mention the matter, wrote: 'The feet must be broad and flat. The vulgar opinion that the dog is web-footed . . . has no other foundation in fact

than that the toes of all dogs are connected by a skinny membrane, but it does not extend to the point of the toes as in web-footed birds' (Cassell's 'Book of the Dog,' p. 69, 1881).

Since, however, the authoritative testimony of Cuvier and Geoffroy St. Hilaire can hardly be dismissed in the summary and concise manner adopted by Mr. Shaw, and since zoologists are sure to consult Darwin for information on a point of this kind, and to accept as true the uncontradicted statements of others contained in his volume, I think it may be useful to publish in our 'Proceedings' figures and descriptions of the feet of some of our breeds of dogs, to show the actual extent of the interdigital web. To ascertain this the hairs, long or short, clothing this web and growing between the pads in all domesticated dogs, have been cut away, and the figures here published are taken from the paws after clipping. The drawings are partially diagrammatic in the sense that the digital pads are represented as lying in the same plane as the rest of the lower surface of the foot, whereas, naturally, they incline upwards in a plane of varying steepness, according to the breed. One or two additional points in which the feet have been modified by selective breeding, or in correlation with other features, have also been referred to.

I was induced in the first instance to look into the question of the alleged palmation of the feet of Newfoundland dogs and of some European breeds, by finding that the feet of various wild species of the family belonging to several valid and nominal genera of so-called wolves, jackals, and foxes, only differ to a small degree, *inter se*, in the extension of the web along the edges of the digital pads*. The feet of some species, it is true, are more webbed than others in the sense that the toes are more widely separable, but this is attributable to the greater width of the integument connecting adjacent toes and permitting their wider separation.

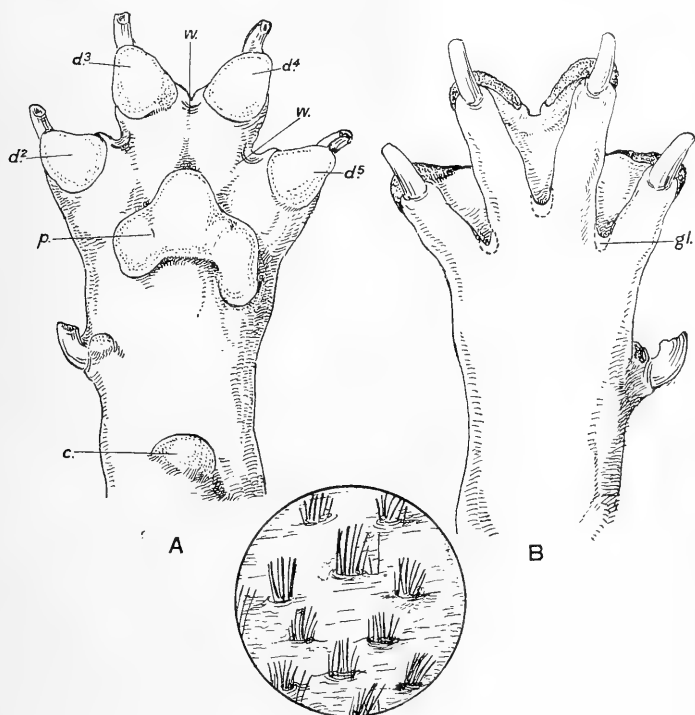
For the material examined for the purpose of this notice, I am indebted partly to Mr. A. J. Sewell, M.R.C.V.S., partly to Mr. R. E. Holding, but mainly to Mr. B. Gorton, M.R.C.V.S., the Society's Veterinary Surgeon. The series comprising, I think, the extremes of modification met with in the dogs, with the exception possibly of the Dachshund, which I have been unable to procure, shows that the feet differ remarkably in length from the wrist to the digital pads, in the length of the digits, the width, length, and shape of the plantar pad, the width across from the second to the fifth toes and the length of the hair between the pads, and other minor features; but very little in the extent to which the hair spreads over the pads, and scarcely at all in the extension of the web along the margins of the digital pads.

The web passes between the inner proximal angles of the third and fourth digital pads, and from the inner proximal angle of the

* There is only one exception to this, which I shall refer to in a subsequent publication.

second and fifth to the outer proximal angles of the third and fourth. The edges of the web are thick and elastic, and the elasticity keeps the toes in a compact mass when the foot is slack, but permits their separation under the weight of the standing

Text-figure 1.



A. Left fore paw of Clumber Spaniel, from below.

c., carpal pad; *p.*, plantar pad; *d2*, *d3*, *d4*, *d5*, digital pads of second third, fourth, and fifth digits; *w.*, web.

B. The same, from above.

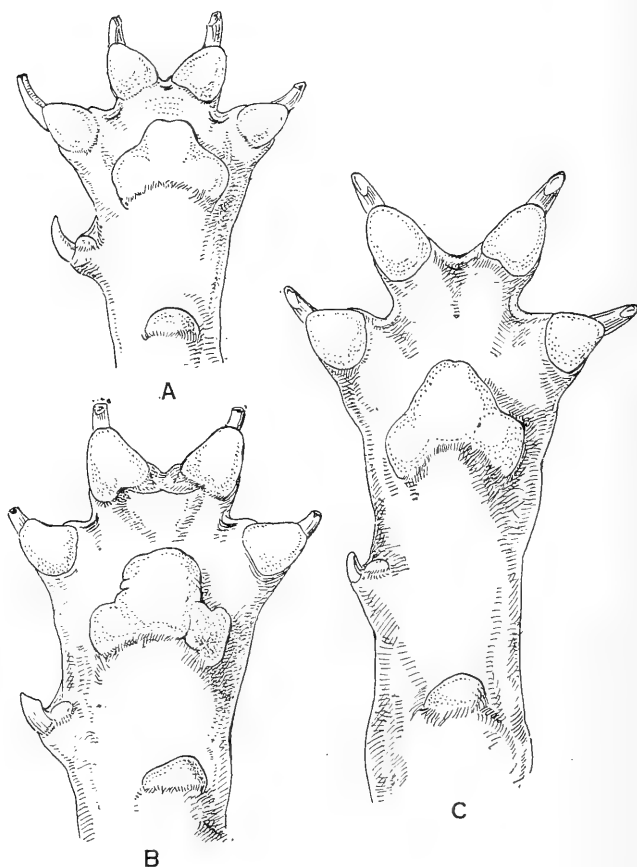
gl., glandular pocket at base of digits.

C. Piece of integument of the interdigital web, showing tufted growth of hair (diagrammatic, the hairs cut quite short).

animal and particularly under the pressure of running. The dog cannot voluntarily expand its toes by overcoming this elasticity when the foot is lifted and, as Mr. Sidney Turner pointed out to me, pressure against the water in swimming is insufficient for the

purpose. Hence the webs themselves can be of little, if any, service for aquatic progression.

Text-figure 2.

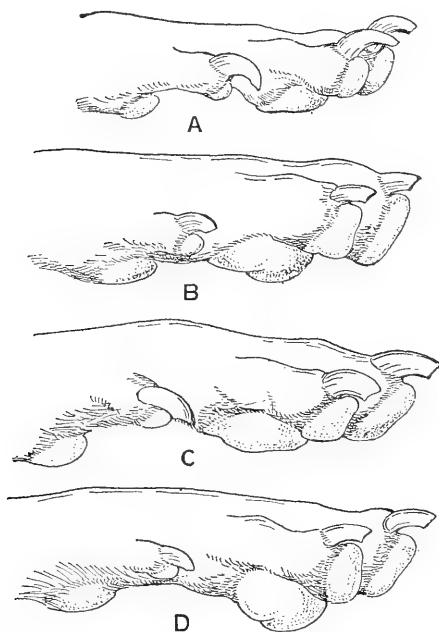


- A. Left fore paw of Aberdeen Terrier, from below.
- B. The same of Bulldog.
- C. The same of Greyhound.

Both the under and upper sides of the web are highly glandular, and on the upper side there is a little naked pocket in the angle formed by the junction of the third and fourth and fourth and fifth toes. This is sometimes absent, and always much shallower, between the second and third toes. The hair clothing the web grows in little tufts from crater-like depressions. The plantar pad varies considerably in length and width, according to the

length and width of the foot. It is comparatively long, for example, in the Greyhound, and broad in the Aberdeen Terrier. The foot of the latter is exceedingly short, owing mainly to the extreme abbreviation of the third and fourth toes, in accordance with the modern fashion for shortening the feet and aligning the metacarpus with the radius. This fashion has also changed the slope of the digital pads, so that they incline nearly at right angles to the long axis of the foot, and has thickened or deepened the plantar pad. These points may be seen by comparing the

Text-figure 3.



- A. Left fore paw of Aberdeen Terrier, from its inner side.
- B. The same of Bulldog.
- C. The same of Clumber Spaniel.
- D. The same of Airedale Terrier.

profile figures of the feet of the Airedale and Aberdeen Terriers and the Bulldog with that of the Clumber Spaniel, which, in the inclination of the digital pads and the depth of the plantar pad, shows more resemblance to the paw of a wolf. The largest and the smallest feet examined were respectively those of a St. Bernard and of a Manchester terrier. The former do not differ materially from those of the Clumber Spaniel, except that the median digits are shorter and approach those of the Aberdeen Terrier.

A feature of the Greyhound's foot is the length of the third and fourth digits and the width of the intervening web which permits their wide separation. In this sense, the fore foot* of this breed is more fully webbed than that of any dog examined; and the wide divarication and length of these digits make the web between them and the second and fifth digits appear to be more deeply and widely scooped out or emarginate than in other breeds. In the Bulldog the web between the third and fourth digits appears to extend farther along the inner edges of the pads than in other dogs; but this is due to the circumstance that a small triangular area of the skin adjoining the inner angles of these pads behind the margin of the web is naked and, simulating the integument of the pad, makes the pads appear to meet across the middle line.

The subjoined table giving some of the principal measurements will show how the feet of the specimens examined vary in relative and actual proportions, the difference between the figures in the first two columns giving the length of the median toes beyond the plantar pad.

If the Greyhound's foot be compared with the Bulldog's it will be seen that the former, although actually very much longer, is considerably narrower across the toes and a little narrower across the plantar pad than the Bulldog's. Again, the foot of the Aberdeen Terrier, which is very short, is much wider than the Pomeranian's and almost as wide as the Greyhound's, and whereas the median toes of the Aberdeen project less than 20 mm. beyond the plantar pad, those of the Greyhound project about 40 mm. beyond it."

	Length from carpal to tip of digital pads.	Length from carpal to tip of plantar pad.	Width of plantar pad	Width across digital pads 2 and 5.
St. Bernard	150 mm.	110 mm.	55 mm.	70 mm.
Greyhound	125 mm.	84 mm.	35 mm.	48 mm.
Retriever	118 mm.	80 mm.	38 mm.	50 mm.
Clumber Spaniel ...	95 mm.	68 mm.	38 mm.	50 mm.
Sheepdog	100 mm.	70 mm.	38 mm.	48 mm.
Pomeranian	75 mm.	53 mm.	27 mm.	35 mm.
Airedale Terrier ...	90 mm.	63 mm.	35 mm.	47 mm.
Bulldog	83 mm.	60 mm.	38 mm.	55 mm.
Aberdeen Terrier ...	63 mm.	45 mm.	35 mm.	45 mm.
Manchester Terrier.	53 mm.	37 mm.	18 mm.	28 mm.

* I was unable to get the hind foot of this dog.

April 7, 1914.

Prof. E. W. MACBRIDE, M.A., D.Sc., F.R.S., Vice-President,
in the Chair.

The SECRETARY, Dr. P. CHALMERS MITCHELL, F.R.S., exhibited the photograph of a female Orang-utan (*Simia satyrus*), kindly sent to him by Mr. W. H. D. Le Souëf, the Director of the Zoological Gardens at Melbourne. According to the statement of Mr. Le Souëf, this Ape had lived in the Gardens at Melbourne for twelve years in an open-air enclosure attached to a shelter without any artificial heat. Orangs were notoriously difficult to keep alive in captivity, and even in Singapore they seldom lived for two years after capture. Mr. Le Souëf's example was certainly extremely interesting. In the Society's own Gardens, a fine male Orang, obtained on Sept. 7, 1905, was still alive, and it was reported to have been in captivity for eight years before it came to London, so that it was still older than the Melbourne example and had shown the cheek-plates for the last two years. Chimpanzees were less delicate, but the average duration was not good. The Chimpanzee known as "Mickie," which had been purchased by the Society on April 6, 1898, was still living, and certainly was the Anthropoid Ape known to have lived longest in captivity. The almost universal experience with Gorillas was that they lived only a few weeks after reaching Europe, and, in consequence of this high mortality, the Secretary had for some years declined to encourage importers by refusing to buy. In one Continental Collection, however, a Gorilla had lived for several years.

The SECRETARY also exhibited two photographs recently sent to him by Surg.-Major George Henderson, M.D., F.L.S., showing a number of specimens of the large-tailed variety of Punjab Domestic Sheep. The tails of some of these animals are so large that they trail on the ground, and a small cart is provided to carry the tail and enable the sheep to move about. One of these carts, harnessed to a sheep, was shown in one of the photographs.

Dr. W. T. CALMAN, F.Z.S., read a report on the River-Crabs (Potamonidæ) collected by the British Ornithologists' Union and Wollaston Expeditions in Dutch New Guinea, containing the descriptions of two new species.

This paper has been published in the TRANSACTIONS.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., read a report on the Mammals collected by the British Ornithologists' Union and Wollaston Expeditions in Dutch New Guinea.

The species obtained numbered 31, of which the types of 12 had been brought home by the Expeditions.

The two Expeditions had obtained a very valuable series of ground-animals, notably of the genus *Uromys*, but there seemed to be, in the part of New Guinea explored, a remarkable absence of arboreal species, these forming in other parts of New Guinea a large proportion of the mammal fauna.

No species were now described as new, as the novelties had been already published in previous papers.

This paper has been published in the TRANSACTIONS.

April 21, 1914.

DR. HENRY WOODWARD, F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the additions to the Society's Menagerie during the month of March 1914:—

The number of registered additions to the Society's Menagerie during the month of March was 109. Of these 20 were acquired by presentation, 29 by purchase, 32 were received on deposit, 16 in exchange, and 12 were born in the Gardens.

The number of departures during the same period, by death and removals, was 217.

Amongst the additions special attention may be directed to:—

2 Grévy's Zebras (*Equus grevyi*) ♀ ♀, from Abyssinia, purchased on March 2nd.

3 Indian Antelopes (*Antilope cervicapra*), presented by H.M. THE KING on March 2nd.

1 Eland (*Taurotragus oryx*) ♀, born in the Menagerie on March 3rd.

1 Ibean Potto (*Perodicticus ibeanus*), new to the Collection, deposited March 2nd.

2 Blue-cheeked Amazon Parrots (*Chrysotis versicolor*), from St. Lucia, presented by E. J. Cameron, C.M.G., on March 2nd.

The SECRETARY announced that the following recommendation from the Committee of Publication was considered by the Council at their meeting held on April 15th last, and adopted:—

AFTERNOON SCIENTIFIC MEETINGS.

The Publication Committee beg to report to Council the result of a post-card ballot on the question of afternoon meetings for Scientific Business.

Notices and ballot-cards were sent to attendants at the Scientific Meetings during the last two years, and to all the members to whom the 'Abstracts' are regularly sent, the total number being 195.

150 replies have been received, and of these 109 are in favour of the change, 39 are against it, and 2 are indifferent.

The Committee therefore recommend that, commencing with the new Session in October 1914, the Meetings for Scientific Business shall be held on Tuesdays at 5.30 P.M., the usual refreshments being served from 5 to 5.30 P.M., and the Publication Committee meeting at 5 P.M.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited the egg of Mantell's Kiwi (*Apteryx mantelli*), laid in the Gardens on April 12th. It weighed $11\frac{1}{2}$ oz., and measured 4.75×2.75 inches. The bird that laid the egg weighed only $65\frac{1}{2}$ oz., considerably less than the weight of a domestic hen, which laid eggs of only $2\frac{1}{4}$ oz.

Dr. P. L. Sclater had recorded the laying of eggs by this species in the Gardens in 1853 and 1860, the weights of which were greater than that of the present specimen, one being $14\frac{1}{2}$ oz. and the other "somewhat larger" (P. Z. S. 1853, p. 350, and 1860, p. 194), and Sir Walter Buller had recorded the weight of an egg taken in the wild state as 15 oz. 90 grs. (Trans. New Zealand Inst. 1892, p. 85).

Mr. STANLEY HIRST, F.Z.S., reported on the Arachnida (other than Spiders) and Myriopoda obtained by the British Ornithologists' Union and Wollaston Expeditions in Dutch New Guinea. The collection is only a small one, but contains two new species of Acari parasitic on mammals and three new species of millipedes. A new species of parasitic mite collected by Prof. F. Forster on various mammals in German New Guinea is also described.

This paper has been published in the TRANSACTIONS.

May 5, 1914.

Dr. HENRY WOODWARD, F.R.S., Vice-President,
in the Chair.

Surgeon G. MURRAY LEVICK, R.N., gave an interesting account of the manners and customs of Adélie Penguins (*Pygoscelis adeliae*), which he had observed at the Cape Adare rookery while with Scott's Antarctic Expedition. He described their mating habits, the making of their "nests," hatching of the eggs, and rearing of the young, and illustrated his remarks with a series of lantern-slides prepared from his photographs.

Antlers of Red Deer.

SIR EDMUND G. LODER, Bt., F.Z.S., exhibited four pairs of antlers of Red Deer (*Cervus elaphus*) and made the following remarks:—

“The Red Deer antlers which I am exhibiting are exceptionally fine specimens. The one from the Carpathians was obtained during the present generation. The horns are very massive and heavy, with long points, and have 20 tines. With a small piece of the frontal bone they weigh $24\frac{1}{2}$ lbs.

The most celebrated collection of Red Deer antlers is at Schloss Moritzburg, belonging to the King of Saxony. The antlers have been collected during the last 300 years and some of them are certainly older than 1611. Only twelve pairs of antlers weigh more than $24\frac{1}{2}$ lbs.

Two very fine pairs of antlers which I exhibit were found in a morass in Hungary. It is not easy to guess from the appearance of the bone, etc., how long they had been there, but I do not take them to be prehistoric or of any very great age.

One pair measures 51 in. in length, $11\frac{3}{4}$ in. round the burr, and 50 in. in greatest outside spread.

The longest Red Deer horns known measure $53\frac{3}{8}$ in.

The other pair found in the morass has the great outside spread of $58\frac{3}{4}$ in., and measure $10\frac{3}{4}$ in. round the burr; with 18 tines.

The fourth pair comes from Germany, and the animal was probably killed many years ago. The horns measure 48 in. in length, $9\frac{3}{4}$ in. round the burr, and $51\frac{3}{4}$ in. in greatest spread; with 20 tines.

We have always known that the Red Deer of Persia, Asia Minor, and the Caucasus had longer faces than those of Germany, France, and Britain; and I thought that the faces of the Deer would be longer the farther East one found them, and that in the Carpathians they would be intermediate between those of Germany and Persia—from which country comes the type of *Cervus elaphus maral*.

Quite lately I have had the opportunity of measuring several skulls of deer which had been killed in the Caucasus and in the Carpathians, and I found them practically identical in their proportions and with equally long faces.

The measurements taken are the distance between the lower edges of eye orbits, and from occipital crest to end of premaxillaries.

Roughly, I find in the short-faced type the ratio is 1 to 3.3, and in the long-faced type 1 to 3.6. I do not attach any great weight to these figures as the material has been so limited.

I have hunted up the skulls of Red Deer in the Natural History Museum and measured those which I found, but there are no specimens from France, Germany, Austria, Hungary, or the Carpathians.

It would appear that there may be some place in Hungary where the short-faced type and long-faced type may be found close together.

A book has lately been published by an Austrian gentleman on the Management of Deer Forests, and in this book he mentions that in some part of Hungary two types of Stags are to be met with; he describes one as of a grey colour and the other of a red colour. He says nothing about the shape of the skulls, but I think it is quite probable that the grey-coloured stag may turn out to be the long-faced *Cervus elaphus maral*.

It is much to be desired that more specimens of skulls (with or without horns) should be obtained from different localities."

The following are the weights and measurements (in inches) of the specimens exhibited:—

	Weight of horns.	Length on curve.	Girth of burr.	Girth above burr.	Girth between bez and trez.	Tip to tip.	Widest inside.	Widest outside.	Number of points.
Carpathians ...	24½ lbs.	44½	11½	10¼	7¼	14½	28¾	44½	20
Found in a morass in Hungary.	21 lbs.	51	11¾	9½	7¼	28½	39½	50	14
Found in a morass in Hungary.	23½ lbs.	48	10¾	9¼	7	38	43	58¾	18
Germany	18¾ lbs.	48	9¾	8¾	6½	33¼	41½	51¾	20

May 19, 1914.

R. H. BURNE, Esq., M.A., Vice-President, in the Chair.

The SECRETARY submitted the following report on the additions to the Society's Menagerie during the month of April 1914.

The number of registered additions to the Society's Menagerie during the month of April was 244. Of these 172 were acquired by presentation, 35 by purchase, 12 were received on deposit, 3 in exchange, and 22 were born in the Gardens.

The number of departures during the same period, by death and removals, was 153.

Amongst the additions special attention may be directed to:—

2 Elephant-Seals (*Macrorhinus leoninus*) ♂ ♀, from the

Antarctic Seas, presented by H.G. The Duke of Bedford, K.G., Pres. Z.S., on April 6th.

2 Indian Elephants (*Elephas maximus*) ♂ ♂, from India, presented by 'The Daily Mirror' on April 1st.

2 Tigers (*Felis tigris*) ♂ ♀, from Burma, presented by Major F. Bigg Wither on April 27th.

1 Binturong (*Arctictis binturong*), from Malacca, purchased on April 6th.

A Collection of Mammals and Birds, including 2 Bonda's Squirrels (*Sciurus saltuensis bondae*), 1 Collared Peccary (*Dicotyles tajacu*), 2 White-browed Hares (*Sylvilagus superciliosus*), new to the Collection; 1 Pileated Heron (*Pileolodius pileatus*), new to the Collection, 1 Prince Albert's Curassow (*Crax alberti*), and 1 Banded Tinamou (*Crypturus noctivagus*), from Rio César, Colombia, presented by W. K. Pomeroy, F.Z.S., on April 29th.

A Collection of Small Birds from Chili, including Chilean Starlings (*Curacus atterimus*), Little Saffron Finches (*Sycalis minor*), and others, presented by George H. F. Duncan, F.Z.S., on April 20th.

3 Sharp-nosed Terrapins (*Nicoria nasuta*), from Colombia, new to the Collection, presented by Dr. H. G. F. Spurrell, F.Z.S., on April 28th.

1 Merrem's Xenodon (*Xenodon merremii*), and 1 Neuwied's Viper (*Lachesis neuwiedii*), both new to the Collection, from Cordova, Argentina, presented by Wilfred A. Smithers, C.M.Z.S., on April 28th.

Mrs. R. HAIG THOMAS, F.Z.S., exhibited a number of skulls, head-skins, and photographs of hornless antelopes found by Mr. A. W. Haig in 1903 on the Dinder River, a tributary of the Blue Nile. There were two varieties, one larger than the other. On his return Mr. Haig submitted the skulls, skins, and photographs to the authorities at the British Museum, who, while admitting a difference in the formation of the skulls, stated their view that the evidence for the existence of hornless antelopes was insufficient and that the specimens shown might have been females.

In 'The Nile Tributaries of Abyssinia,' first published in 1867, Sir Samuel Baker tells us he met with and shot hornless antelopes on the Royan, a tributary of the Atbara, and we read farther on that the animal was already known to science and classified by Rüppell. Thus it is shown that Baker's and Haig's hornless antelopes were found on the same watershed, in a geographical position not a hundred miles apart.

Mr. D. M. S. WATSON, M.Sc., F.Z.S., exhibited two specimens of *Procolophon trigoniceps*, a Cotylosaurian Reptile from South Africa, and drew attention to certain sexual differences in this species.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

March 17th, 1914.

Prof. E. A. MINCHIN, M.A., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of February, 1914.

Mr. R. H. BURNE, M.A., F.Z.S., exhibited a specimen of the palate of a female Bactrian Camel and a lantern-slide of a Hunterian preparation of the throat of a male Common Camel from the Royal College of Surgeons Museum, showing in each a fleshy appendage attached to the palate some inches in front of its free posterior border on a level with the anterior pillars of the fauces.

This appendage, though rudimentary in the female, is of great size in the male, and during the rutting season can be distended and protruded from the mouth, and is in some way secondarily connected with the sexual functions.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited a set of lantern-slides illustrating the structure of the feet in Domestic Dogs, with special reference to the extension of the interdigital integument.

Two papers were received from Mr. L. N. G. RAMSAY, M.A., B.Sc., entitled: (1) On the Annelids of the Family Nereidæ

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

collected by Mr. F. A. Potts in the N.E. Pacific in 1911, with a Note on *Micronereis* as a Representative of the Ancestral Type of the Nereidæ; (2) On the Genera *Ceratocephale* Malmgren and *Tylorrhynchus* Grube.

Mr. A. KNYVETT TOTTON contributed an account of the Structure and Development of the Caudal Skeleton of the Teleostean Fish *Pleuragramma antarcticum*.

Mr. G. C. ROBSON, B.A., read a report on Mollusca from Dutch New Guinea collected by the British Ornithologists' Union and Wollaston Expeditions. In general, the collection appears to endorse Hedley's views as to the Oriental affinities of the Papuan molluscan fauna. Though numerically small in species and individuals, the collection has yielded two genera and three new species, the anatomy of all of which is described. The two new genera, which were obtained from considerable altitudes, viz. 10,500 ft. and 14,200 ft. respectively, are of considerable interest, though their precise affinities are as yet uncertain. In any case they cannot be regarded as typical members of the Xonitidæ, though an aggregate of anatomical characters exhibits the characters of that family. An account of the anatomy of *Papuina lituus* (Lesson) is given, and discrepancy between the anatomical and conchological relationships of a new species of *Papuina* is discussed.

This paper will be published in the TRANSACTIONS in due course.

Prof. H. MAXWELL LEFROY, M.A., F.Z.S., Curator of Insects, communicated Mr. P. R. Awati's paper on "The Mechanism of Suction in *Lygus pabulinus* Linn.," a Capsid bug injurious to the foliage of the potato, on which it feeds. A detailed description of the morphology and anatomy of those organs of the head concerned in sucking the plant-juices is followed by an account of their mode of action, in part deduced from their structure and arrangement, in part derived from observation of the living insect. The potato-leaf is pierced by the conjoined maxillary and mandibular stylets, the labrum and labium serving to direct and steady them at the point of puncture. The inner (maxillary) stylets are grooved along their apposed surfaces in such a way as to form two canals, one conducting to the cavity of the pharynx, the other to a salivary pump in connection with the salivary glands. Suction is effected by muscles which raise the flexible dorsal wall of the pharynx.

The investigation was conducted by means of serial sections, in the making of which attention to certain details of technique was found to be essential. An historical summary is given of work on the homologies of the mouth-parts of the Rhynchota.

Mr. K. G. BLAIR, B.Sc., read his report on the Heteromorous Coleoptera collected by the British Ornithologists' Union and the Wollaston Expeditions in Dutch New Guinea.

The most interesting feature of the collection, from the point of view of distribution, is the occurrence of *Cissites maxillosa* Fab. in this region. This Beetle has been hitherto regarded as peculiar to the Oriental Region, its range extending from Assam to Java, Borneo, and the Philippine Islands; it has also been found in Ceylon.

The three species of *Amarygmus* belong to a section of the genus that makes New Guinea its headquarters; a few species of this section are found in the extreme north of Australia, but the majority of the Australian species belong to other groups.

Of the fourteen species noted, the following seven are described as new :—

SETENIS COSTIPENNIS, sp. n.

Atra, parum elongata, capite prothoraceque dense rugoso-punctatis, hoc antice et postice bisinuato, lateribus crebre crenatis, disco medio longitudinaliter impresso utrinque obsolete bi-impresso, angulis anticis rotundatis, posticis acutis; elytris subtiliter punctato-striatis, intervallis opacis plus minusve costulatis, costis nitidis, intervallo tertio et 5^o et 7^o basi magis elevatis; corpore subtus pedibusque nitidis parce punctulatis, tibiis omnibus extus late sulcatis, sulcis opacis. Long. 18-21 mm.

AMARYGMUS VIRIDIÆNEUS, sp. n.

Ovalis, viridi-æneus, nitidus, corpore subtus pedibusque rufescentibus; sulcis ocularibus nullis, antennis rufo-piceis, prothoracis lateribus arcuatim angustatis, dorso vix perspicue punctulato; elytris striato-punctatis, intervallis vix convexis, vix punctatis. Long. 11, lat. 6 mm.

AMARYGMUS UTAKWENSIS, sp. n.

Elongato-ovalis, æneus sat nitidus, corpore subtus cum pedibus rufo-piceis. Præcedenti similis, magis elongatus, omnino fortius punctatus, striarum punctis confertioribus. Long. 10½, lat. 5½ mm.

AMARYGMUS WOLLASTONI, sp. n.

Elongato-ovalis, nitidus, cyanæus; prothorace subtiliter punctulato; elytris striatis, striis sat subtiliter punctulatis, punctis et striis ipsis griseo-nigris, intervallis antice planis postice convexis; corpore subtus pedibusque nigris subnitidis, tarsis rufo-setosis. Long. 12, lat. 6 mm.

STRONGYLUM WOLLASTONI, sp. n.

Nigrum, nitidum, elytris obscure cæruleo-nigris, corpore subtus pedibusque obscure piceis; capite inter oculos foveolato, clypeo medio transverse sulcatulo, prothorace transverso, lateribus leviter sinuatis tenuiter marginatis, angulis anticis oblique truncatis, posticis rectis, disco inæquali medio obsolete sulcato, ante basin transverse impresso, impressione crebre punctata; elytris basi prothorace valde latioribus post scutellum leviter impressis, striato-punctatis, punctis suturam et apicem adversus minoribus, intervallis parum convexis; pedibus sat gracilibus, femoribus leviter clavatis, tibiis omnibus leviter sinuatis. Long. 15 mm.

MORDELLA SERICEOBRUNNEA, sp. n.

Grandis, elongata, brunnea parum iridescens, omnino setulis fulvis sericeis induta; capite post oculos expanso angulis fere rectis, palpis brunneis, articulo ultimo triangulariter elongato, antennis gracilibus prothoracis medium haud superantibus, articulis 4-10 intus serratis vix transversis; prothorace valde transverso elytris latiore, antice et postice medio valde lobato, disco inter lobos rotundato-elevato, lateribus arcuatis; scutello elongato-triangulari, apice rotundato; elytrise longatis, transverse subtiliter rugulosis, sutura marginata, humeris obtuse elevatis; abdominis apice acute sat breve caudato, tarsis posterioribus compressis. Long. 15, lat. 4½ mm.

SESSINIA STOTHERTI, sp. n.

Fusco-testacea, elytris fuscis; prothorace elongato, apicem versus parum angustato, punctis disci ante medium majoribus et parvioribus; elytris fuscis, subtilissime sat dense punctulatis et sericeo-pubescentibus, obsolete tricostatis. Long. 9-10½ mm.

This paper will be published in the TRANSACTIONS in due course.

A paper on the Malay race of the Indian Elephant was received from Mr. R. LYDEKKER, F.R.S., F.Z.S. The author made the young Negri Sembilan Elephant, formerly living in the Society's Gardens, the type of a new race, *Elephas maximus hirsutus*, subsp. n., characterized by the square, instead of triangular, form of the ear, the early date at which its upper margin is bent over, and the presence in the young condition—at least, in some cases—of a thick coat of black and in part bristly hair.

Prof. W. J. DAKIN, D.Sc., F.L.S., F.Z.S., contributed two papers on the Fauna of Western Australia, dealing with the Onychophora and the Phyllopoda respectively.

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 7th, 1914, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.F. E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—XIII. On Two new Species belonging to the Genera *Oochoristica* and *Linstowia*, with Remarks upon those Genera.

E. W. SHANN, B.Sc.

On the Nature of the Lateral Muscle in Teleostei,

W. T. CALMAN, D.Sc., F.Z.S.

Report on the River-Crabs (Potamonidæ) collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

OLDFIELD THOMAS, F.R.S., F.Z.S.

Report on the Mammals collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

GUY DOLLMAN.

Notes on a Collection of East African Mammals presented to the British Museum by Mr. G. P. Cosens.

The following papers have been received :—

Surgeon JOSEPH C. THOMPSON, U.S.N.

Further Contributions to the Anatomy of the Ophidia.

Miss ALBERTINA CARLSSON.

On the Fossil Carnivores *Cynodictis intermedius* and *Cynodon gracilis* from the Phosphorites of Quercy.

The Rev. T. R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

Crustacea from the Falkland Islands collected by Mr. Rupert Vallentin, F.L.S.—Part 2.

STANLEY HIRST, F.Z.S.

Report on the Arachnida and Myriopoda collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

J. S. HUXLEY, F.Z.S.

The Courtship-habits of the Great Crested Grebe (*Podiceps cristatus*); with an Addition to the Theory of Sexual Selection.

Major J. STEVENSON HAMILTON, C.M.Z.S.

The Coloration of the African Hunting Dog (*Lycan pictus*).

C. TATE REGAN, M.A., F.Z.S.

Notes on *Aristeus goldiei* Macleay, and on some other Fishes
from New Guinea.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
March 24th, 1914.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

April 7th, 1914.

Prof. E. W. MACBRIDE, M.A., D.Sc., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY, Dr. P. CHALMERS MITCHELL, F.R.S., exhibited the photograph of a female Orang-utan (*Simia satyrus*), kindly sent to him by Mr. W. H. D. Le Souëf, the Director of the Zoological Gardens at Melbourne. According to the statement of Mr. Le Souëf, this Ape had lived in the Gardens at Melbourne for twelve years in an open-air enclosure attached to a shelter without any artificial heat. Orangs were notoriously difficult to keep alive in captivity, and even in Singapore they seldom lived for two years after capture. Mr. Le Souëf's example was certainly extremely interesting. In the Society's own Gardens, a fine male Orang, obtained on Sept. 7, 1905, was still alive, and it was reported to have been in captivity for eight years before it came to London, so that it was still older than the Melbourne example and had shown the cheek-plates for the last two years. Chimpanzees were less delicate, but the average duration was not good. The Chimpanzee known as "Mickie," which had been purchased by the Society on April 6, 1898, was still living, and certainly was the Anthropoid Ape known to have lived longest in captivity. The almost universal experience with Gorillas was that they lived only a few weeks after reaching Europe, and, in consequence of this high mortality, the Secretary had for some years declined to encourage importers by refusing to buy. In one Continental Collection, however, a Gorilla had lived for several years.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

The SECRETARY also exhibited two photographs recently sent to him by Surg.-Major George Henderson, M.D., F.L.S., showing a number of specimens of the large-tailed variety of Punjab Domestic Sheep. The tails of some of these animals are so large that they trail on the ground, and a small cart is provided to carry the tail and enable the sheep to move about. One of these carts, harnessed to a sheep, was shown in one of the photographs.

Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper on the anatomy and systematic arrangement of the Cestoidea, in which he described two new species of Tapeworms belonging to the genera *Linstowia* and *Oochoristica*.

A paper was received from Mr. E. W. SHANN, communicated by Prof. W. C. MCINTOSH, F.R.S., C.M.Z.S., on "The Lateral Muscle of Teleostei." The author has undertaken the present work in view of the conflicting statements extant as to the nature of the lateral muscle in Teleostean fishes; the primary object of the paper is to uphold the single-layer theory of its composition. After an historical summary of previous investigators, some personal observations are recorded dealing with the External Conformation and the Internal Structure. In conclusion, setting aside the dorsal and ventral "carinales" muscles and the "red muscle" (which occupies the furrow in which the lateral nerve is situated), the lateral muscle is held to be divided into a dorsal and a ventral longitudinal moiety by the horizontal septum beneath the lateral line. These moieties are in turn divided (after Humphry) into mesio-dorsal, latero-dorsal, latero-ventral, and mesio-ventral portions, as defined by the external conformation of the myocommata; a new step is made in the correlation of these external areas with the underlying structure. The view of the conical or pyramidal structure of the myomeres recently advanced by Chevrel is maintained and to some degree amplified. The paper forms a preface to part of an extensive study on the myology of the pectoral region of fishes.

Dr. W. T. CALMAN, F.Z.S., read a report on the River-Crabs (Potamonidæ) collected by the British Ornithologists' Union and Wollaston Expeditions in Dutch New Guinea, containing the descriptions of two new species.

This paper will be published in the TRANSACTIONS.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., read a report on the Mammals collected by the British Ornithologists' Union and Wollaston Expeditions in Dutch New Guinea.

The species obtained numbered 31, of which the types of 12 had been brought home by the Expeditions.

The two expeditions had obtained a very valuable series of ground-animals, notably of the genus *Uromys*, but there seemed

to be, in the part of New Guinea explored, a remarkable absence of arboreal species, these forming in other parts of New Guinea a large proportion of the mammal fauna.

No species were now described as new, as the novelties had been already published in previous papers.

This paper will be published in the TRANSACTIONS.

Mr. GUY DOLLMAN read a paper, communicated by OLDFIELD THOMAS, F.R.S., F.Z.S., on the Mammals obtained by Mr. Wilmoughby P. Lowe during the recent East African Expedition organized by Mr. G. P. Cosens. The entire collection, some two hundred specimens in all, was presented by Mr. Cosens to the National Collection.

Besides examples of many rare and important species, specimens of the following new forms were included :—

GERBILLUS COSENSI, sp. n.

Allied to *G. dunni*, but smaller and duller in colour.

Head and body 75 mm.; tail 129; hind foot 25.

Hab. Kozibiri River, Ngamatak, Turkwel River.

Type. Male. B.M. No. 13.10.18.64.

TATERILLUS LOWEI, sp. n.

Allied to *T. nubilus*, but very much paler in colour.

Head and body 107 mm.; tail 160; hind foot 28.

Hab. 10 miles west of the Ngamatak Hills, Turkwel River.

Type. Male. B.M. No. 13.10.18.66.

EPIMYS WALAMBÆ AMALÆ, subsp. n.

Allied to *E. walambæ pedester*, distinguished by its smaller size, buff-tinted flanks, and white ventral surface.

Head and body 144 mm.; tail 127; hind foot 26.

Hab. Lemek Valley, between the Amala River and Southern Guaso Nyiro.

Type. Female. B.M. No. 13.10.18.111.

EPIMYS COUCHA PALLIDA, subsp. n.

Allied to *E. coucha neumani*, smaller in size and without any buff suffusion on ventral surface.

Head and body 87 mm.; tail 100; hind foot 21.

Hab. Kamchuru, Lohor, Central Province, Uganda.

Type. Male. B.M. No. 13.10.18.99.

ARVICANTHIS RUMRUTI PALLESCENS, subsp. n.

Allied to *A. rumruti*, larger in size and much paler in colour.

Head and body 130 mm.; tail 109; hind foot 26.

Hab. Loita Plains, British East Africa.

Type. Male. B.M. No. 13.10.18.142.

CEPHALOPHUS GRIMMIA LUTEA, subsp. n.

Allied to *C. grimmia abyssinicus*, distinguished by its far paler colour and smaller teeth.

Head and body 870 mm.; tail 76; hind foot 225; ear 101.

Hab. Mt. Maroto, N.E. Karamoja, Central Province, Uganda.

Type. Female. B.M. No. 13.10.18.164.

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 21st, 1914, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

Surgeon JOSEPH C. THOMPSON, U.S.N.

Further Contributions to the Anatomy of the Ophidia.

The Rev. T. R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

Crustacea from the Falkland Islands collected by Mr. Rupert Vallentin, F.L.S.—Part 2.

STANLEY HIRST, F.Z.S.

Report on the Arachnida and Myriopoda collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

Major J. STEVENSON HAMILTON, C.M.Z.S.

The Coloration of the African Hunting Dog (*Lycaon pictus*).

C. TATE REGAN, M.A., F.Z.S.

Notes on *Aristeus goldiei* Macleay, and on some other Fishes from New Guinea.

J. S. HUXLEY, F.Z.S.

The Courtship-habits of the Great Crested Grebe (*Podiceps cristatus*); with an Addition to the Theory of Sexual Selection.

MISS ALBERTINA CARLSSON.

On the Fossil Carnivores *Cynodictis intermedius* and *Cynodon gracilis* from the Phosphorites of Quercy.

The following papers have been received :—

R. C. LEWIS, M.A.

On Two new Species of Tapeworms from the Stomach and Small Intestine of a Wallaby, *Lagorchestes conspicillatus*, from Hermite Island, Monte Bello Islands.

C. H. O'DONOGHUE, D.Sc., F.Z.S.

Notes on the Circulatory System of Elasmobranchs.—I. The Venous System of the Dogfish (*Scyllium canicula*).

H. B. PRESTON, F.Z.S.

Diagnoses of new Genera and Species of Zonitidæ from Equatorial Africa.

B. F. CUMMINGS.

Scent-Organs in Trichoptera.

P. D. MONTAGUE, B.A.

A Report on the Fauna of the Monte Bello Islands.

G. C. ROBSON, B.A.

Cephalopoda from the Monte Bello Islands.

MISS M. J. RATHBUN.

Stalk-Eyed Crustaceans collected at the Monte Bello Islands.

TOM IREDALE.

Report on Mollusca collected at the Monte Bello Islands.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

April 14th, 1914.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

April 21st, 1914.

Dr. HENRY WOODWARD, F.R.S., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY announced that the following recommendation from the Committee of Publication was considered by the Council at their meeting held on April 15th last, and adopted:—

AFTERNOON SCIENTIFIC MEETINGS.

The Publication Committee beg to report to Council the result of a post-card ballot on the question of afternoon meetings for Scientific Business.

Notices and ballot-cards were sent to attendants at the Scientific Meetings during the last two years, and to all the members to whom the 'Abstracts' are regularly sent, the total number being 195.

150 replies have been received, and of these 109 are in favour of the change, 39 are against it, and 2 are indifferent.

The Committee therefore recommend that, commencing with the new Session in October 1914, the Meetings for Scientific Business shall be held on Tuesdays at 5.30 P.M., the usual refreshments being served from 5 to 5.30 P.M., and the Publication Committee meeting at 5 P.M.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of March, 1914.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited the egg of Mantell's Kiwi (*Apteryx mantelli*), laid in the Gardens on April 12th. It weighed $11\frac{1}{2}$ oz., and measured 4.75×2.75 inches. The bird that laid the egg weighed only $65\frac{1}{2}$ oz., considerably less than the weight of a domestic hen, which laid eggs of only $2\frac{1}{4}$ oz.

Dr. P. L. Sclater had recorded the laying of eggs by this species in the Gardens in 1853 and 1860, the weights of which were greater than that of the present specimen, one being $14\frac{1}{2}$ oz. and the other "somewhat larger" (P. Z. S. 1853, p. 350, and 1860, p. 194), and Sir Walter Buller had recorded the weight of an egg taken in the wild state as 15 oz. 90 grs. (Trans. New Zealand Inst. 1892, p. 85).

Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., communicated a paper by Surgeon J. C. THOMPSON, U.S.N., entitled "Further Contributions to the Anatomy of the Ophidia."

The Rev. T. R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., read a paper on Crustacea from the Falkland Islands. At intervals during a period of some fifteen years Mr. Rupert Vallentin, F.L.S., has used prolonged opportunities for collecting, among other things, the crustacean fauna of the Falkland Islands. An initial report on this subject was made to the Society in the year 1900. In January of the present year Dr. Thomas Scott, in the 'Annals and Magazine of Natural History,' has discussed some of the Copepoda. The contribution now offered has to do chiefly with the Malacostraca. Five new species are proposed:—*Tanais ohlini*, robust, with the sides parallel, unindented, the pleon with its telsonic segment the longest, the uropods six-jointed; *Tryphosites chevreuxi*, in which the third pleon segment has the lower part of the hind margin on each side convex and serrate, with no upturned tooth; *Monoculopsis vallentini*, having a very short process to the wrist of the second gnathopods; *Bovallia regis*, with round eyes and the lower borders of all the peræon segments extended laterally outwards; and *Paradexamine nanus*, founded on an ovigerous female, a tenth of an inch long, with the body feebly dentate. A new genus is defined for the species "*Cymodocea darwinii*" Cunningham. The synonymy of Dana's "*Spheroma calcarea*" is adjusted. Cunningham's *Iphimedia normani* is transferred to Chevreux's genus *Paraphimedia* with notes and illustrations, and light is thrown upon the obscure *Lembos fuegiensis* (Dana).

Dr. P. CHALMERS MITCHELL, M.A., F.R.S., F.Z.S., gave an account of Mr. Julian S. Huxley's paper on "The Courtship Habits of the Great Crested Grebe; with an Addition to the Theory of Sexual Selection."

Mr. STANLEY HIRST, F.Z.S., reported on the Arachnida (other than Spiders) and Myriopoda obtained by the British Ornithologists' Union and Wollaston Expeditions to Dutch New Guinea. The collection is only a small one, but contains two new species of Acari parasitic on mammals and three new species of millipedes. A new species of parasitic mite collected by Prof. F. Förster on various mammals in German New Guinea is also described.

This paper will be published in the TRANSACTIONS.

Major J. STEVENSON HAMILTON, C.M.Z.S., sent a short paper on the coloration of the African Hunting-Dog (*Lycaon pictus*).

Mr. C. TATE REGAN, M.A., F.Z.S., contributed a note on *Aristeus goldiei* Macleay, and on some other Fishes from New Guinea.

Miss A. CARLSSON's paper, communicated by Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., dealt with two species of fossil Carnivora, from the Phosphorites of Quercy, contained in the collections of the Zootomical Institute at Stockholm.

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 5th, 1914, at half-past Eight o'clock P.M., when the following communications will be made :—

EXHIBITIONS AND NOTICES.

Surgeon G. MURRAY LEVICK, R.N.

Lecture on the Manners and Customs of Adélie Penguins, illustrated with lantern-slides from the author's photographs.

R. C. LEWIS, M.A.

On Two new Species of Tapeworms from the Stomach and Small Intestine of a Wallaby, *Lagorchestes conspicillatus*, from Hermite Island, Monte Bello Islands.

H. B. PRESTON, F.Z.S.

Diagnoses of new Genera and Species of Zonitidæ from Equatorial Africa.

The following papers have been received :—

C. H. O'DONOGHUE, D.Sc., F.Z.S.

Notes on the Circulatory System of Elasmobranchs.—I. The Venous System of the Dogfish (*Scyllium canicula*).

B. F. CUMMINGS.

Scent-Organs in Trichoptera.

P. D. MONTAGUE, B.A.

A Report on the Fauna of the Monte Bello Islands.

G. C. ROBSON, B.A.

Cephalopoda from the Monte Bello Islands.

Miss M. J. RATHBUN.

Stalk-Eyed Crustaceans collected at the Monte Bello Islands.

TOM IREDALE.

Report on Mollusca collected at the Monte Bello Islands.

R. C. L. PERKINS, M.A., D.Sc., F.Z.S.

The Species of the Genus *Paralastor* Sauss, and some other Hymenoptera of the Family Eumenidæ.

GEORGE JENNISON.

Notes on Plumage Development in the African Wood-Stork.

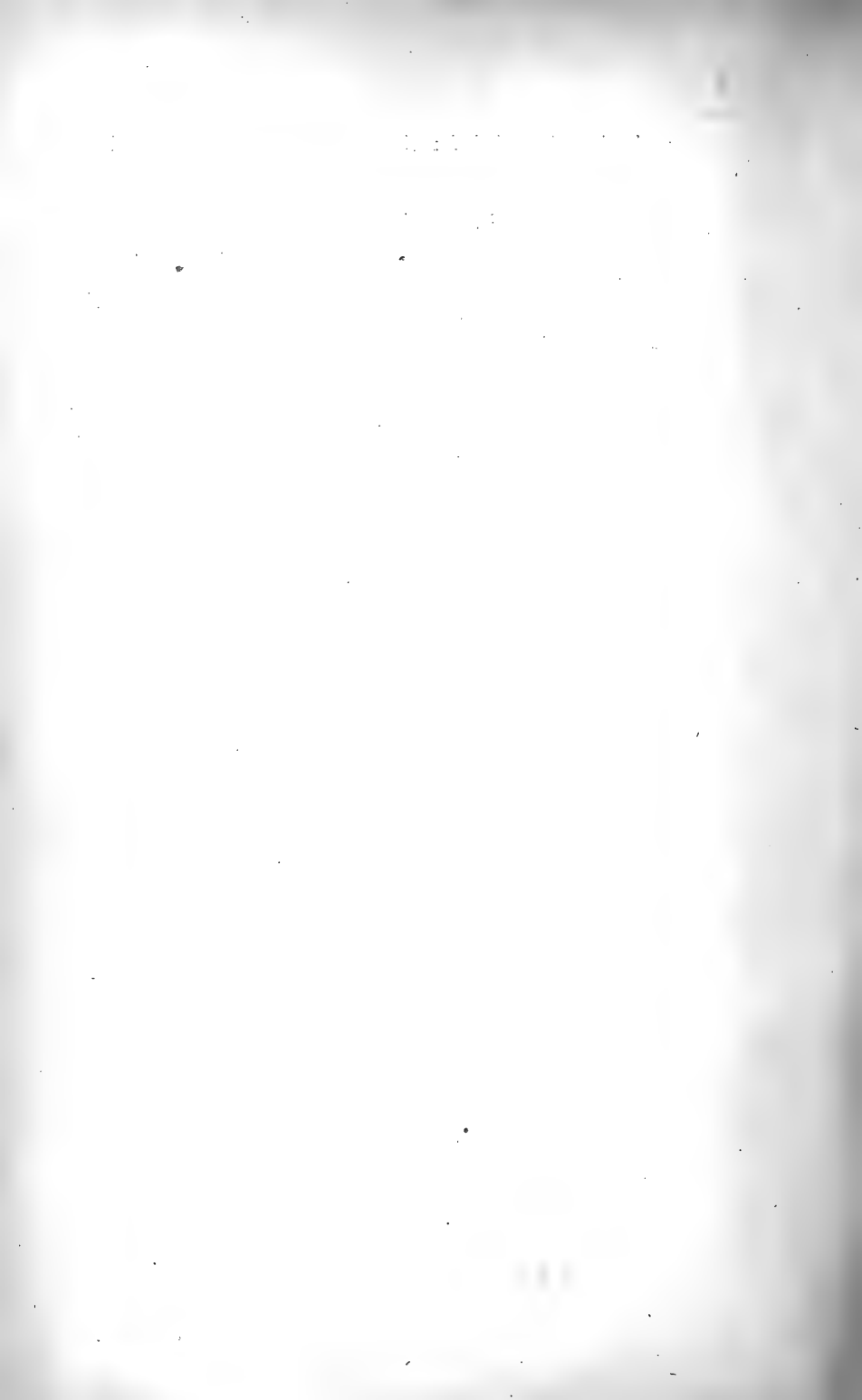
H. A. BAYLIS.

On a new Cestode from an Albatross (*Diomedea irrorata*).

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
April 28th, 1914.



ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 5th, 1914.

Dr. HENRY WOODWARD, F.R.S., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Sir EDMUND G. LODER, Bt., F.Z.S., exhibited four European Red Deer Antlers of unusual size, and remarked on the distribution of the long-faced and short-faced types of *Cervus elaphus* in Europe.

Surgeon G. MURRAY LEVICK, R.N., gave an interesting account of the manners and customs of Adélie Penguins (*Pygoscelis adeliae*), which he had observed at the Cape Adare rookery while with Scott's Antarctic Expedition. He described their mating habits, the making of their "nests," hatching of the eggs, and rearing of the young, and illustrated his remarks with a fine series of lantern-slides prepared from his photographs.

Mr. R. C. LEWIS, M.A., read a paper, communicated by Prof. E. W. MACBRIDE, D.Sc., F.R.S., V.P.Z.S., on two new species of Tapeworms from the stomach and small intestine of a Wallaby from Hermite Island, Monte Bello Islands. The parasites belong to the genus *Cittotania*, having two full sets of genital glands in each proglottis. The posterior border of each segment overlaps the next succeeding segment to a marked degree in both species.

The specimens were collected by Mr. P. D. Montague on a recent expedition to the Monte Bello Islands, and were compared

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

with specimens in the collections at the Berlin Museum, Natural History Museum, Zoological Gardens, and London School of Tropical Medicine.

MR. OLDFIELD THOMAS, F.R.S., F.Z.S., contributed a paper "On a remarkable Case of Affinity between Animals inhabiting Guiana, W. Africa, and the Malay Archipelago."

The case referred to was that of the Pygmy Squirrels (*Nannosciurinae*), known to be natives of W. Africa and the Malay Archipelago, and of which Mr. Thomas was now able to state that the Guianan "*Sciurus pusillus*" was also a member. It was sufficiently distinct to need generic separation (*Sciurillus*, gen. nov., was suggested as a name for it), but was unquestionably assignable to the *Nannosciurinae*, and not to the *Sciurinae*, to which all the other American, all the European, and all the Asiatic continental Squirrels belonged.

So rare and striking a case deserved prominent record, so that students of geographical distribution might have their attention directed to it.

MR. H. B. PRESTON, F.Z.S., presented a paper containing diagnoses of new genera and species of Zonitidæ from Equatorial Africa. The material on which the paper is based was recently collected from many localities in British East Africa, Uganda, and the Belgian Congo by Messrs. A. Blayney Percival, Robin Kemp, and C. W. Woodhouse, and descriptions are given of seventy-six new species, two new varieties, and eight new genera of Zonitidæ, to which latter a number of hitherto-described forms are also referred; the author points out that, as far as the present collections show, scarcely any of the South African generic names in this group are applicable to the Central African species, and also that the various genera and species of the family do not seem to show peculiar local characters as is the case with the agnathous molluscs from the same regions.

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 19th, 1914, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.C. H. O'DONOGHUE, D.Sc., F.Z.S.

Notes on the Circulatory System of Elasmobranchs.—I. The Venous System of the Dogfish (*Scyllium canicula*).

B. F. CUMMINGS.

Scent-Organs in Trichoptera.

GEORGE JENNISON.

Notes on Plumage Development in the African Wood-Stork.

H. A. BAYLIS.

On a new Cestode from an Albatross (*Diomedea irrorata*).

D. M. S. WATSON, M.Sc., F.Z.S.

On the Deinocephalia, an Order of Mammal-like Reptiles.

R. C. L. PERKINS, M.A., D.Sc., F.Z.S.

The Species of the Genus *Paralastor* Sauss. and some other Hymenoptera of the Family Eumenidæ.

The following papers have been received :—

P. D. MONTAGUE, B.A.

A Report on the Fauna of the Monte Bello Islands.

G. C. ROBSON, B.A.

Cephalopoda from the Monte Bello Islands.

MISS M. J. RATHBUN.

Stalk-Eyed Crustaceans collected at the Monte Bello Islands.

OM IREDALE.

Report on Mollusca collected at the Monte Bello Islands.

W. A. CUNNINGTON, M.A., Ph.D., F.Z.S.

Zoological Results of the Third Tanganyika Expedition conducted by Dr. W. A. Cunningham, 1904-1905. Report on the Parasitic Eucopepoda.

F. F. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement
of the Cestoidea.—XIV. On a new Species of *Rhabdometra*
and on the Paruterine Organ in *Otiditenia*.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
May 12th, 1914.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 19th, 1914.

R. H. BURNE, Esq., M.A., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY submitted a Report on the Additions to the Society's Menagerie during the month of April, 1914.

Mrs. R. HAIG THOMAS, F.Z.S., exhibited a number of skulls, head-skins, and photographs of hornless antelopes found by Mr. A. W. Haig in 1903 on the Dinder River, a tributary of the Blue Nile. There were two varieties, one larger than the other. On his return Mr. Haig submitted the skulls, skins, and photographs to the authorities at the British Museum, who, while admitting a difference in the formation of the skulls, declared there were no hornless antelopes and that all the specimens shown must have been females, treating the observations of the travellers as of no moment.

In 'The Nile Tributaries of Abyssinia,' first published in 1867, Sir Samuel Baker tells us he met with and shot hornless antelopes on the Royan, a tributary of the Atbara, and we read farther on that the animal was already known to science and classified by Rüppell. Thus it is shown that Baker's and Haig's hornless antelopes were found on the same watershed, in a geographical position not a hundred miles apart.

Evidently our British Museum Catalogue of the Mammalia requires revision—it is sixty years out of date.

Mr. D. M. S. WATSON, M.Sc., F.Z.S., exhibited two specimens of *Procolophon trigoniceps*, a Cotylosaurian Reptile from South Africa, and drew attention to certain sexual differences in this species.

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Dr. C. H. O'DONOGHUE, F.Z.S., read a paper "On the Venous System of the Dogfish." The general disposition of the main trunks in *Scyllium* is similar to that described in other Elasmobranchs, but the details differ considerably. Owing to a misinterpretation of certain vessels in the embryo, the vein usually described as the subclavian in the adult is, in reality, the subscapular, and the vein bringing back blood from the pectoral fin and the abdominal wall, *i. e.* the true subclavian, is generally omitted altogether.

The details of the hepatic portal factors which differ considerably from other Elasmobranchs are described for the first time. In most vertebrates the whole of the blood from the gut is collected by the hepatic-portal vein, but in *Scyllium* a well-marked intestino-mesenteric vein conveys blood from part of the intestine to the post-cardinal sinus.

Although developmentally the anterior cardinal sinus and the post-cardinal sinus open into the ductus Cuvieri in the adult, owing to the dilation of the two sinuses, the anterior cardinal sinus and the ductus Cuvieri open into the post-cardinal sinus.

The posterior cerebral vein leaves the skull with the vagus nerve and enters the front end of the anterior cardinal sinus, a point that has been overlooked in other Elasmobranchs.

Mr. B. F. CUMMINGS read a paper, communicated by the Secretary, on the "Scent-Organs in Trichoptera," in which he gave an account of the remarkable development of the palpi of the first maxilla in a male Caddis-fly, *Sericostoma personatum*. Instead of being 5-segmented, the palpus consists of a single swollen segment carrying an enormous tuft of long silky hairs, at the bases of which unicellular scent-glands are situated. The existence of scent-glands was suggested by a previous author in describing the courtship of this species. The palpus was studied in serial sections, and the modifications in the structure of the rest of the head are detailed. Scent-organs are well known to occur in Lepidoptera and other insects, but have not previously been described from the Trichoptera.

Mr. H. A. BAYLIS, B.A., described a new species of Cestode collected from an Albatross (*Diomedea irrorata*) by Dr. H. O. Forbes in Peru and presented by the Hon. N. C. Rothschild to the British Museum.

A paper on "The Deinocephalia, an Order of Mammal-like Reptiles," was read by Mr. D. M. S. WATSON, M.Sc., F.Z.S., in which the skull of a Tapinocephaloid is almost completely described; its most important morphological features are the large quadrate and the fact that the temporal fossa is completely surrounded by the postorbital and squamosal.

In the post-cranial skeleton the most important features are

the fact that in the pectoral girdle the precoracoid is entirely excluded from the glenoid cavity, the whole girdle being very like that of Gorgonopsids, and the plate-like pelvis. The Russian type *Deuterosaurus* is a Tapinocephaloid. The Titanosuchids seem to agree in general features with the Tapinocephaloids and *Rhopladon* belongs to the "family."

The fact that whilst in the skull Deinocephalia agree with the American Pelycosaur, whilst in the post-cranial skeleton they resemble South African Therapsids, shows that the American forms must be included in the same great group, super-order, as the South African mammal-like reptiles.

The conditions of the Therapsid middle ear are discussed in the paper.

Dr. R. C. L. PERKINS, M.A., F.Z.S., sent a paper dealing with the species of the genus *Paralastor* and some other Hymenoptera of the family Eumenidæ. All the described species are enumerated therein, together with the descriptions of many new forms.

Mr. GEORGE JENNISON contributed some notes on colour-development in the Indian Wood-Stork (*Pseudotantalus leucocephalus*).

A paper received from Dr. PH. LEHRS, and communicated by Dr. G. A. BOULENGER, F.R.S., F.Z.S., contained the description of a new Lizard from the Canary Islands, recently discovered by Dr. Cæsar Boettger on Hierro :—

LACERTA CÆSARIS, sp. n.

Closely related to *L. galloti* D. & B., but size much smaller (66 to 77 mm. from snout to vent) and pattern of coloration more primitive from a phyletic point of view, a light vertebral streak being present in both sexes. 90 to 110 scales across the middle of the body; ventral shields in 10 or 12 longitudinal series; rostral usually touching the nostril; occipital broader than long.

The next Meeting of the Society for Scientific Business, which closes the Session 1913-14, will be held on Tuesday, June 9th, 1914, at half-past Eight o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

P. D. MONTAGUE, B.A.

A Report on the Fauna of the Monte Bello Islands.

G. C. ROBSON, B.A.

Cephalopoda from the Monte Bello Islands.

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Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—XIV. On a new Species of *Rhabdometra* and on the Paruterine Organ in *Otiditænia*.

A. W. WATERS, F.L.S., F.G.S.

The Marine Fauna of British East Africa, from Collections made by Cyril Crossland, M.A., B.Sc., F.Z.S., in the Years 1901-1902.

R. I. POCKOCK, F.R.S., F.L.S., F.Z.S.

- I. On the Facial Vibrissæ of Mammals.
- II. On the Feet and other External Characters of the Ursidæ and Canidæ.

D. M. S. WATSON, M.Sc., F.Z.S.

Procolophon trigoniceps: a Cotylosaurian Reptile from South Africa.

G. A. BOULENGER, D.Sc., F.R.S., F.Z.S.

On a Second Collection of Batrachians and Reptiles made by
Dr. H. G. F. Spurrell, F.Z.S, in the Choco, Colombia.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

May 26th, 1914.

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NOTICE.

The 'Proceedings' for the year are issued in four parts, paged consecutively, so that the complete reference is now P. Z. S. 1914, p. . . . The Distribution is as follows:—

Part I. issued in March.

" II. " June.

" III. " September.

" IV. " December.

'Proceedings,' 1914, Part I. (pp. 1-226), were published on March 26th, 1914.

The Abstracts of the 'Proceedings,' Nos. 130-134, are contained in this Part (77)





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